EXPERIMENTS
UPON THE
HUMAN BILE.

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BRITISH MUSEUM

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EXPERIMENTS
UPON THE
HUMAN BILE:
AND
REFLECTIONS
ON THE
BILIARY SECRETION.
WITH AN
INTRODUCTORY ESSAY.

By JAMES MACLURG, M.D.

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——*juſſit quod ſplendida* Bilis. Hor.

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C'eſt une erreur de croire, q'une experience aveugle, et une habitude mechanique, tiennent lieu de principes ſûrs, et de maximes fondées ſur un ſolide raiſonnement—————— ——————

Traduct. d'un diſcours ſur la commerce, par
M. le Marquis BECCARIA.

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INTRODUCTION.

THERE is no art, unleſs this term can be applied to religion, which ſeems to require in its profeſſors ſuch a perfect harmony of opinion, as the art of medicine. For there is none in which error is of ſo much conſequence, or where a fluctuation of the mind between oppoſite ſentiments is attended with ſuch anxious diſtreſs. Yet medicine has its ſchiſms; and the ſages of our art, while they appear devoted to Truth, forget her peculiar caprice; that, though ſhe loves to be purſued with ardour, ſhe muſt ſtill be addreſſed with indifference.

THE keeneſt ſhafts of ridicule have frequently been levelled at this trait in the medical character. Our ſingular gravity and ſolemnity placed us, as it were, in oppoſition to the free, the gay, and the witty; and they eagerly ſeized a circumſtance, which ſeemed to reduce this extraordinary figure to the common ſize; and to ſhow, under a face of great wiſdom, much ignorance and uncertainty.

We have replied to theſe gentlemen, that phyſic, like the other ſciences founded on experience, is continually progreſſive, and therefore ſubject to perpetual change; ſo that, without the ſuggeſtions of vanity, we may ſometimes be tempted to differ from our venerable anceſtors. And it might have been ſubjoined, that phyſicians, notwithſtanding ſome curious external differences, which would deceive perhaps an unexperienced Houynhnm, are yet no better than mere Yahoos. But it ſeems to be agreed, among the philoſophers who have examined this ſpecies with the greateſt accuracy, that *to aſſociate* is not more a principle of human nature than *to ſeparate*. For, though men have been allured by the proſpect of advantage, or compelled by force, to unite themſelves in vaſt bodies; yet it was always obſerved, that where the political bands which held them together were weak, and they could follow their natural tendency, theſe huge piles ſoon broke into a number of pieces. And in all the countries where the arts of policy had ſcarcely taken root, the inhabitants have been found divided into numerous tribes, inflamed againſt each other with a mutual animoſity. In like manner, proceed theſe philoſophers, we have ſeen a ſet of religious notions overrun half the globe: but the torrent ſoon ſplit into a multitude of ſtreams; and numerous ſects aroſe, who perſecuted each other with an unrelenting fury. It is not attraction alone which governs the material world: the laws of repulſion have alſo their influence; and it looks as if they had both their analogous principles in the moral ſyſtem.

BUT theſe internal factions, which range us under the banners of ſo many leaders, are equally oppoſite to a ſet of men who will acknowledge the authority of neither. The ſticklers for different ſyſtems, however averſe to each other, unite like the domeſtic parties of reſtleſs Britons againſt a common enemy. It is hard to ſay when this quarrel began between empirics and dogmatiſts, or when it will end. It ſeems to be as ancient as the origin of reaſoning in phyſic, which could not be long after the beginning of obſervation itſelf; nor will it ceaſe, moſt likely, until our philoſophy has acquired perfection; an æra ſtill more remote.

Every ſtep of experience approaches towards ſyſtem; ſince, by diſcovering the natural relation of things, it prepares us for eſtabliſhing principles. And theory, or the application of theſe principles in explaining the phenomena around us, is the favourite proceſs of the human mind. So delighted are we with it, that we cannot wait the neceſſary preparation; and our eagerneſs would fain anticipate thoſe principles which yet remain to be diſcovered. A vapoury gleam of fancy is miſtaken for the ray of ſcience; and we purſue it through all the treacherous ways of hypotheſis.

For, though things, being related in nature, preſent themſelves in a certain order to the view of the obſerver, he does not immediately diſcover that order which is invariable. Amidſt the variety of circumſtances which ſurround any fact, to ſeize that whereon it neceſſarily depends, requires a cloſe attention, and commonly a varied experience. But the mind will follow in the mean time its propenſity; and theories are produced, and deſtroyed, by ſucceſſive obſervation.

SYSTEM has ſo often fallen under the ſtroke of experience, that we have been led to imagine a natural enmity between them; which, by an eaſy tranſition, is extended to their ſeveral patrons. A theoriſt and an empiric are, in medicine, terms of mutual reproach, and as much the badges of two oppoſite parties, as thoſe of Whig and Tory uſed to be in politics.

AMIDST the recriminations of both ſides, it ſeems to be acknowledged, that improvement in our ſcience has ever been the fruit of growing experience; and that a multitude of errors have been ſanctified by the authority of ſyſtems. And it is imagined that we go but a little farther, when we affirm that theſe are uſeleſs, and even dangerous; that, far from aiding the progreſs of medicine, they lie in its way, or miſlead its ſteps.

But their danger, in the preſent ſtate of phyſic, is ſurely imaginary. If they inflict a wound, they bring along with them its remedy.

——— ——— *Qua cuſpide vulnus*
Senſit, et hâc ipſâ cuſpide ſenſit opem.

The continual ſucceſſion of ſyſtems prevents their acquiring an influence injurious to philoſophic liberty. Their oppoſition has had the ſame effect in ſcience, that the quarrels of contending popes produced in religion. It baniſhed the notion of infallibility, which is ſo apt to be foſtered by the blind veneration of a ſect. Thoſe gigantic forms of ſuperſtition, and authority, that were encountered with difficulty, and even danger, by the firſt literary knights-errant, no longer bar the avenues to ſcience. Every ſubject is diſcuſſed by a free diſpute; and the repeated appeals to reaſon and common ſenſe, prove that we acknowledge no authority which is not derived from them.

THIS notion of a dangerous influence in ſyſtematics, may ſuit a ſupine, an ignorant, and a ſuperſtitious age; but has no relation to the preſent, which is ſo remarkable for its free and active ſpirit of enquiry.

BUT ſhall we grant that they are uſeleſs; and is it credible that the induſtry of theſe gentlemen ſhould be ſo active to no ſort of purpoſe? A ſyſtem cannot be built without materials; and theſe can be furniſhed only by obſervation. Empirics claim this field as their own: but it is evident that the dogmatic alſo muſt cultivate it; and he will cultivate it with greater ardour, and probably with more ſucceſs. It is paſſion which excites the talents, as well as virtues, of the ſoul to their moſt admired efforts. We are aſtoniſhed at his unwearied induſtry, whoſe curious eye ſeeks every where ſupport for a favourite doctrine. And it is a certain fact, that the ſphere of obſervation has been farther extended by dogmatics, than by the men who pretend to give it ſo much merit.

YET it is not a mere acquaintance with particulars in detail; but a knowlege of their relations, and eſpecially of that important one by which they are fitted to produce one another, that we are chiefly intereſted in acquiring. And this knowlege ſhould naturally reſult from the full and large compariſon, which muſt precede every attempt at arrangement. Obſervations which had long remained ſolitary and neglected, are brought together, and acquire an uſeful importance. Some ſteps are made in forming principles; and the maſs of confuſed experience begins to put on regularity and diſtinctneſs.

AND though our aſſociations ſhould not be exactly agreeable to the order of Nature, yet they have ſome advantage, as they aſſiſt the memory; which with difficulty retains a ſet of unconnected facts. Without the aid of ſyſtem, the informations of experience muſt ſlide imperceptibly down the tide of oblivion; for no one could collect any number of them; and he would be ſtill leſs able to deliver them to others. On this account, ſyſtem is neceſſary in phyſic, as it is in natural hiſtory. In the former, indeed, it pretends to explain the animal operations, and to ſhow us how we may influence them; and is founded, therefore, on the relation of cauſe and effect. As this is no object of the ſenſes, but an inference of our fallible reaſon, it is extremely apt to be miſtaken. The attempts of the medical ſyſtematic will frequently miſcarry;

carry; yet ſtill it muſt be acknowledged that his errors are readily detected. His courſe is regular, and may eaſily be traced.

BUT while he feels a warm affection for the child of his own fancy, he purſues, with ſevereſt ſcrutiny, the ſchemes of every rival theoriſt. He expunges what was abſolutely falſe; and limits what an enthuſiaſm, ſimilar to his own, had extended beyond its proper bounds. A ſucceeding dogmatiſt ſhows him the ſame impartiality; and lops, with as little tenderneſs, the luxuriant growth of an over-heated imagination. One is ready to believe that this ardour, ſo well adapted to invention and new combinations, corrected by that *ſang-froid* which a man poſſeſſes in examining the works of another, though a perpetual ſource of private diſſenſion, muſt tend, at leaſt, to the general good, and quicken the progreſs of ſcience.

And accordingly we obſerve, that as the riſe and ſtruggle of parties denote firmneſs and health in our excellent political conſtitution, ſo the perpetual growth and contention of ſyſtems is a mark of vigour in the ſtate of medical knowlege. When Europe was ſunk in ignorance, and every ſort of improvement languiſhed, Galen tyrannized for ages in the ſchools of phyſic. The firſt dawning of the rays of ſcience

> ———*Ubi pulſam Hyemem ſol aureus egit*
> *Sub terras, cœlumque æſtivâ luce recluſit.*

ſeemed to reſtore ſome activity to the torpid minds of men, and diſcloſed the buds of another ſyſtem. But, ſince that period, they have been germinating continually; and their decay ſeems to be proportionably accelerated. Boerhaave acquired the greateſt authority in modern times; but his own pupils have thrown it off, and introduced innovations of the utmoſt importance.

This prolific birth, as well as tranſitory exiſtence of ſyſtems, are evidently connected with the progreſs of experiment and obſervation. They remind us of the antient fable of Saturn and his offspring, while they appear to devour the theories to which they gave origin. Yet it is unjuſt to charge the ſureſt faculties of our nature with theſe unnatural, and ſhort-lived productions. The information of the ſenſes is right and true; though the opinions which we form in conſequence are often erroneous. It is theſe opinions, the precipitate combinations of that buſy organ the fancy, which experience diſſipates in its courſe, while it unveils the more beautiful order of Nature. And if, in its progreſs through the ſeries of connected being, it ſhould ever reach the ultimate point, our ſyſtem will be that of the world, and repreſent exactly the diſpoſition of things, which flowed originally from Almighty Will. In any other point of this progreſs, our arrangements muſt evidently be deficient; and, from a ſtrong propenſity of the mind to carry things to perfection, and to give them the appearance of a whole, we ſhall be continually ſupplying ſomething from the imagination. This, I confeſs, ſhould prevent our being wedded to a ſyſtem: yet we may certainly treat it as a miſtreſs; embrace it with ardour at preſent, and diſcard it whenever we are diſguſted with its defects, or attracted by the ſuperior qualities of another. For, the beſt ſyſtem is only the expreſſion of our degree of knowledge, at the time of its production; and their continual change, while it diſcovers their weakneſs, is a mark of their growth and tendency toward perfection.

But, as theſe ſyſtems are the offspring of obſervation, ſo do they guide, and aſſiſt its ſteps. They preſent a mixed proſpect, where ſome parts are fully illumined by experience; while others are only faintly diſtinguiſhed; or buried, perhaps, in a total obſcurity. This is the chaos of ſcience; and it is the buſineſs of the human mind, while it traces with wonder the operations of the divine, to diffuſe over it the beauty of order. And though a difference of diſpoſition, or more frequently of ſituation, will lead one to obſervation, and another to arrangement; their labours, far from being oppoſite, are mutually neceſſary. The quarrel between empirics and dogmatics is unnatural. As well might the ſenſes quarrel with the intellect, and each pretend to exerciſe their function ſeparately. Every one ſees, that they are uſeful only as combined; and that their excellency conſiſts in their aiding, and correcting each other.

To exclaim againſt every kind of ſyſtem, has been reckoned a proof of earneſt zeal for obſervation. Yet what is it, really, but to declare, that we muſt reſt ſtupid, and indifferent ſpectators of the train of facts continually paſſing before us? For, in viewing them with any care, we ſoon perceive that ſome in the ſucceſſion are intimately related. The attention excited purſues theſe through a variety of caſes, proportioned to the extent of our ſphere of obſervation. And a more than natural coldneſs muſt guard the temper, which eſcapes the effect of an emotion that hurries the mind into theory. A mere obſerver is a very uncommon creature; and we are rarely preſented, with facts, unmixed with ſpeculative notions. More frequent is that precipitation, which from obſerving the connection of certain facts, in a few inſtances, pronounces it to be conſtant and neceſſary. A perfect indifference about the matter may ſecure us from this error; but ſurely a fever of the mind, which tends, though irregularly, to uſe and improvement, is preferable to a fatal torpor, ſuſpending its moſt important operations.

The error will be corrected by the progreſs of experience; and frequently, in an inquiſitive age, the having formed a falſe opinion will lead to the diſcovery of the truth; becauſe it directs the attention, that ſource of all diſcoveries, to a particular point.

THE number of abſurd theories ſhould not, therefore, inſpire us with an antipathy to the term; nor muſt a panic terrour of them baniſh phyſicians from the ſacred temple of philoſophy. To be hurt with the imperfect, and puerile commencements of reaſoning in phyſic, and to relinquiſh the hopes of a rational theory, is to be offended at the childiſh prattle of infancy, and to expect nothing better from a maturer age. That Being; who formed the mind of man peculiarly capable of improvement, and though he fixed the limits of exiſtence, and of the acquiſition of knowlege in the individual, appointed no ſuch boundaries in the ſpecies; has implanted in our breaſts, together with curioſity, a fondneſs of ſyſtem; and it is juſtified by the relations of things. Experience, while it diſcovers theſe relations, gives occaſion to the exerciſe and diſplay of that paſſion. If, therefore, we are determined to reject all ſyſtem in medicine, let us oppoſe every obſtacle to the natural progreſs of knowledge. We may begin with rejecting thoſe ſciences, anatomy, chymiſtry, and every branch of phyſics, which delude us continually with the hopes of penetrating into the ſecrets of the œconomy. Impenetrable dulneſs ſhould henceforth be as neceſſary an appendage to the profeſſion, as inflexible gravity. Genius muſt quit, in deſpair, a walk ſo little accommodated to his exertions; and the art, conſidered as a mere ſpecies of traffic, muſt fall into the hands of the ſtupid, and ſordid part of mankind.

LET the ſons of dullneſs, and indolence; or if there ſhould be found a phyſician of extenſive practice, with a naturally barren, and little-improved underſtanding, let him deny the uſe of theory. We believe, moſt ſincerely, that he is ignorant of its proper uſe; and when he finds that all the profits of medicine can be reaped without ſuch a troubleſome inſtrument, he may really think it unneceſſary,

Geſtit enim Nummum in loculos demittere, poſthoc Securus. ———

YET there are ſome, it is ſaid, to whom the progreſs of our art is leſs indifferent, that have adopted the ſame notion. Diſeaſes, they apprehend, like the other productions of Nature, are known and diſtinguiſhed by their ſenſible properties; and their cure is only taught by experience. What occaſion then for theory, which has ſo often deceived us? The knowledge of diſeaſes, and of their remedies, can only be acquired by an aſſiduous attention to practice; and an hoſpital is the only uſeful ſchool of phyſic.

NOR ſhall we deny, that a certain aſſemblage of ſymptoms gives to diſeaſes their ſenſible form. It is the arrangement of theſe forms, according to their relations and differences, which makes the buſineſs of noſologiſts. They adopted the method, that had appeared ſo ſucceſsful in the diſtribution of animals and vegetables. But theſe are multiplied continually in the ſame form; and Nature has drawn a line between their ſeveral ſpecies, which effectually prevents their confuſion.

WHAT are the ſpecies of diſeaſes? A fever, a diarrhœa, a jaundice, an epilepſy, are apprehended to be all of a diſtinct nature; yet they ſometimes concur in the formation of one diſeaſe. From the different conſtitution of the machine in individuals, the conſpiration of its parts, and the influence of thoſe external powers to which it is continually expoſed, its diſorders appear under a great variety of forms. To determine what ſymptoms, in any combination, are eſſential, and mark the ſpecific nature of the diſeaſe, muſt frequently be a difficult taſk. It will certainly require that ſymptoms be traced to their origin; that the hiſtorian ſhould turn philoſopher; and we may probably differ as much in our noſological arrangement, as in our reaſoning on the phenomena of diſeaſes.

In the mineral kingdom, the method of the botaniſts was found inſufficient; and ſoon yielded to one erected on a chemical inveſtigation. For here, the limits of combination are ſo wide, and the conſequent productions ſo various, that our attention was confounded, when we directed it only to their external and obvious qualities. An enquiry into their compoſition, has furniſhed us with an uſeful diſtribution of them, according to eſſential differences.

The ſymptoms of diſeaſes may be conſidered as a language in which Nature addreſſes us; as ſigns whoſe meaning we are to inveſtigate. We muſt not be contented with merely obſerving them, any more than with ſimply remarking the phenomena of the inanimate world; but ſhould endeavour to trace them to thoſe laws of the œconomy on which they depend. The improvement of anatomy and chymiſtry, the diſſection of morbid bodies, and experiments on living animals, have certainly carried us ſomeway in this enquiry; and by ſettling the theory of diſeaſes, have contributed to mend, or confirm our practice.

If this practice had attained perfection; if every diſeaſe was defined, and the beſt method of treating it exactly determined; there would, indeed, be no occaſion for theory. Yet, though we could ſuppoſe that men, conducted by their mere feelings, had reached this pitch of excellence, in the moſt difficult of human arts; we muſt ſtill have commended that curioſity, which, not contented with ſimple imitation, ſhould attempt to draw the veil; and by diſcovering the reaſons of this ſucceſsful proceeding, eſtabliſh it on the beſt and ſureſt ground. But if we modeſtly acknowledge a practice, which is ſo various, to be ſtill imperfect; and if diſeaſes will occur either entirely new, or ſo altered that the mere light of experience cannot guide us in their treatment; we ſhall not readily give up thoſe principles, which muſt conduct us where example fails. Yet it cannot be denied, that ſucceſsful modes of practice have grown up, we know not from what origin; or have been introduced by the moſt ignorant empirics. But have not very uſeful machines been invented by people, who were ignorant of the principles by which they were governed? And does it follow, that a knowledge of the laws of mechanics is of no uſe to the artiſt?

BUT theory carries the mind through the whole circle of ſciences, in its ſearch after analogous phenomena to explain thoſe of life; and in its enquiry into the powers which influence the animal operations. And ſome have imagined that this diffuſion of the attention is unfavourable to the progreſs of medicine. Their idea ſeems to have been taken from a view of thoſe arts, which are brought to perfection by means of their ſubdiviſion into the minuteſt branches. Nor do they find any abſurd analogy in ſuppoſing, that as our ſhoes are much better, ſince each manœuvre in their ſtructure has employed the whole ſkill and addreſs of a reaſonable creature; ſo the management of diſeaſes might be rendered much more dexterous, by limiting the attention of the phyſician. And, in conſequence of this doctrine, they have propoſed to make every diſeaſe the care of a particular perſon; juſt as wiſely as ancient ſuperſtition believed that every tree of the grove required its tutelary deity.

THE mere arts may be improved by repeated ſubdiviſions; but thoſe which partake of the nature of ſciences require a different method of cultivation. It is the remark of a celebrated hiſtorian, that the art of war, for ſome centuries the only object of attention to all the gentry of Europe, acquired little improvement in the hands of men, who deſpiſed every other ſort of knowledge. A perſonal dexterity in the management of their arms was common enough; but an extenſive ſyſtem of operations required an acquaintance with principles,

ples; which mere habit could never teach.

The Reader, I hope, will not find any thing whimſical in this compariſon of arts, which have equally the appellation of murderous; nor be led to fancy that a dogmatic and an empiric differ like a Mareſchal Turenne and a ſavage warrior; chiefly becauſe the former purſues more ſcientifically his deſtructive ſchemes. A leſs exceptionable illuſtration may be found in the progreſs of an art very cloſely connected with medicine.

While the knowledge of chymiſts was confined to the operations within the laboratory, their art, though deſtined to throw a light on ſo many parts of nature, was full of myſtery and confuſion. The variety of phenomena, multiplied by every day's experience, inſpired an admiration that aroſe to enthuſiaſm, and gave probability to their abſurdeſt fancies. They did not attempt to explain theſe phenomena, by ſhewing their relation to what happened in other parts of Nature; for they were acquainted with no other part. But the mind will always be ſtriving to generalize its notions; and ſyſtem is as natural to mankind as invention. Certain facts made a more forcible impreſſion on them: to theſe they referred every phenomenon which had any appearance of analogy; and they erected them into governing principles of the world. They beheld every where the operation of acids, alkalis, nitre, and ſulphur; and corrupted the theory of medicine. The eye of a philoſopher pierced this cloud, which the manœuvres of a thouſand artiſts ſeemed only to render more thick and obſcure. It was indeed a philoſopher; one who looked through Nature, and diſcovered the ſprings of that variety of movements which form the changing ſcene of our world. It was Sir Iſaac Newton!

THE ſciences, like the graces, march hand in hand; and nothing would be more vain than an attempt to purſue any one of them ſeparately. Yet it will be objected, perhaps, that the animal œconomy has ſo little in common with the reſt of Nature, that its facts can never be explained from any view of the phenomena of the inanimate world.

AND indeed, the firſt movers in our machine ſeem to have little analogy with other natural powers; and to be paſt finding out. But is it certain that they will always appear under this aſpect? The moſt common phenomena of electricity, and the lightning of heaven, had preſented themſelves together to the view of mankind for ſome thouſand years: yet no one ſuſpected that appearances, which affect the ſenſes and the imagination ſo differently, could have a common origin. But may not other Newtons, and other Franklins, extend ſtill farther the boundaries of ſcience? We can ſay nothing concerning the unknown parts of Nature, except from the notion of a conſiſtency in the whole plan. And many philoſophers, obſerving that the various appearances of the univerſe are traced to a few ultimate principles, which ſeem to be themſelves related, were tempted to imagine a common ſource of all the activity obſerved in the material world.

But, however diſtinct our machine may be in its kind, it makes a part of the general ſyſtem; and is ſubjected to the action of all thoſe powers by which it is ſurrounded. And though, perhaps, no animal operation can be underſtood from mere mechanical, or chymical principles; yet it does not follow, that theſe have not really their influence. For the operations are the reſult of the mutual action of ſeveral powers; and generally, in the combination, ſome occur that are unknown, and whoſe effect we cannot value. Our theory, therefore, is rather incomplete, than falſe; and inſtead of being diſcouraged from its uſe, we ſhould be ſtimulated to advance it gradually to perfection.

AND though the animal ſyſtem were ſolitary, and unconnected with the reſt of Nature, a general knowledge would be neceſſary to a phyſician. For it muſt ſtill be admitted that medicine, like the other ſciences founded on experience, is capable of acquiring from induction principles of its own. And we cannot better learn the method of giving it this improvement, than by tracing the progreſs of the mind, in collecting from obſervation the laws of Nature.

The knowledge of a certain routine of hoſpital, or other practice, is not ſufficient therefore to prepare one for the exerciſe of our art; unleſs we would have it to be ſtationary. And there is even a probability, that a man may be continually converſant with diſeaſes, without getting acquainted with them; as one may grow up in his own country, without knowing its characteriſtic manners. Objects muſt be ſeen in different lights, that our attention may be excited to obſerve them. Mere curioſity, though a lively, is a tranſitory paſſion, and is ſatisfied with ſuperficial views. And when once it is ſatisfied, the ſame thing may return a thouſand times, without making any impreſſion. But when it is compared with ſimilar, or contraſted with oppoſite facts, it acquires, as it were, a freſh novelty; and our attention is as powerfully rouſed as by the firſt emotion of curioſity. And here lies a principal advantage of ſyſtem, founded on experience, to the man who applies himſelf to obſervation. Each fact, that preſents itſelf, being viewed with relation to a number of others, all its circumſtances become conſpicuous: and every thing being connected with ſomething elſe makes a deeper impreſſion, and is longer retained by the memory.

But if there is truth in what has been ſaid, nothing can be more abſurd than the vulgar notion of a certain quackiſh dexterity in medicine; which leads men to confide in ignorance, ſupported by its conſtant companion, Preſumption. This notion, which tends to degrade phyſic from the rank of ſciences, is not even applicable to ſurgery; though it is confeſſedly more purely an art than phyſic. The celebrated Petit, of Paris, conſtantly declares in his lectures, that the ſeparation of phyſic and ſurgery is unnatural; and that it would be for the advantage of both, again to unite them. Yet, as far as ſimple dexterity is concerned, the chirurgical art has certainly been improved by the ſeparation; and when this is carried farther, and ſurgery ſplits into ſeveral branches, the dexterity continues to increaſe. We may appeal to thoſe fine manœuvres, for which the oculiſts, auriſts, and dentiſts of the preſent times are ſo much celebrated. But it is not from the dexterity which we ſee diſplayed in artificial productions, that we are to judge of what is required in operations on the animal machine. In the former, it is art which does every thing; but in the latter, all the nicer changes are performed by Nature, who completes and finiſhes what the medical artiſt rudely prepares. It is not, therefore, a mere dexterity which we require in a ſurgeon. We expect that he ſhould be acquainted with the powers of the machine, and be able to tell "*quid ferat, atque faciat natura.*" And thus, his art is ſo ſtrictly connected medicine, as to juſtify the remark of Petit; and though it may be uſeful to practiſe them ſeparately, they ſhould certainly be ſtudied together.

But it muſt be remembered, that when we take up the defence of ſyſtem, it is merely in a general view. Nor ſhould a vindication of the privilege of reaſoning in medicine, be extended to all thoſe modes of exerciſing it, that have frequently proceeded to the length of licentious abuſe. A deſcription of the variety of opinions which they have produced, would look like an attempt to give a hiſtory of the caprices of the human mind. Some of them were ſcarcely born, before they were buried in oblivion,

Oſtendunt Terris hunc tantum fata, &c.

Fate ſhow'd them—but ſo quickly dropt the ſcene,
'Twas ſtraight forgot that they had ever been.

While others, winged with ſtronger fancy, mounted above the weak view of their age; and

Through a cloud
Drawn round about them like a radiant ſhrine,
MILTON.

they ſhone, for a time, the object of univerſal admiration. But they were mere meteors of the night; and as ſoon as we were in a condition to examine them, they diſappeared. Perhaps, many of thoſe theories, which at preſent look ſo firm and durable, are deſtined to a ſimilar fate. One would think that, like the bodies of the ſenſible world, they were continually decaying, and continually reproduced in new forms.

NOR are we ſurpriſed at this account, when we reflect, that a ſyſtem is an attempt to explain the phenomena of the living body in health, and in diſeaſe; and that to make it complete, a perfect knowledge of all the powers of the œconomy, and of their relation to one another, as well as to external agents, is abſolutely neceſſary. But no one imagines that medical ſcience, even in our enlightened age, has reached this point of perfection: and all are agreed that our predeceſſors, the nearer we approach to the origin of experimental philoſophy in Europe, were plunged in a ſtill deeper obſcurity. Much, therefore, of every ſyſtem, though not of every one indifferently, muſt be merely conjectural. But this is the region of fancy, fruitful in prejudice and error; where a variety of circumſtances, even accident itſelf, have frequently a greater influence than reaſon and common ſenſe. And if ſuch is the temper of mankind, that there is ſcarcely an abſurdity which authority cannot ſet up, and habit eſtabliſh, they ſhould treat with ſome indulgence the common frailty,

——————*Æquum eſt*
Peccatis veniam poſcentem reddere rurſus.

By attending to the animal operations, we diſcover facts of a very different kind; ſome of them having an evident analogy with the phenomena of the inanimate world, and ſeeming to be explicable from known principles; while others appear to be totally diſtinct in their nature, and cauſe. The former are conſidered as the effects of ſome of thoſe powers, which we diſtinguiſh by the general appellations of chymical, and mechanical; while the latter are ſaid to depend on an energy peculiar to animals. And thus we arrange, in ſeparate claſſes, the informations of experience concerning the animal machine; and each of them is to furniſh us with principles for explaining its phenomena.

But nothing can be more different than the notion of the limits of theſe ſyſtems, and of their importance in the œconomy, in the minds of different theoriſts. Like the undetermined bounds of the powers of our political conſtitution, they vary continually with the prejudices of the individual. People are extremely apt, from contemplating the operation of certain energies in a variety of inſtances, to grow poſſeſſed with the idea of their conſequence, and to imagine their influence where it is not evident. Phyſicians, from the circumſtances which direct our habits of thinking, have become chymiſts, or mechanics; and applied their favourite principles on every occaſion. Their ſyſtems grew up in the retirement of the cloſet; where men frequently indulge themſelves in ſpeculations, which they never think of applying to the buſy ſcenes of life.

But they who delivered themſelves more to obſervation, and the ſtudy of the animal machine, perceived ſomething in all its affections, which diſtinguiſhed them from every other natural operation. And when they ſaw that analogies from the inanimate world were inadequate to the explanation of the phenomena, they began to think that they ſhould be altogether rejected.

In vitium ducit culpæ fuga, &c.

THE animal operations, they believed, muſt depend on the energy of that being, which reſides only in animals; uninfluenced by mechanical or chymical laws, ſince we get our idea of it, by denying it every property of matter. But reaſon informs us that it is endued with intelligence, and that ſelf-preſervation is the powerful principle of its action. They naturally therefore fell into the doctrine of final cauſes; and conceived that the only way of explaining any fact in the hiſtory of the œconomy, was to ſhew that it was uſeful, or neceſſary.

AND thus have ariſen thoſe ſyſtems of phyſic, which, with the titles of Mechanical, Chymical, and Stahlian, have made the greateſt figure in modern times. They are liable to the common objections againſt ſyſtems in general. They owe their premature birth to our eager deſire of explaining every thing; which cannot wait until the progreſs of obſervation has aſcertained all the principles that are neceſſary to a perfect theory. Their authors are led away by an exceſſive fondneſs of ſimplicity, which they conſider, perhaps, as ornamental to their ideal fabric. They pretend to explain all the operations in the animal body, from the view of one ſet of cauſes; juſt as they trace all the various affections of the ſoul to one common principle.

THE animal machine, though it is connected with the other parts of Nature, is diſtinguiſhed from them; and, while it acknowledges the influence of the common laws of matter, is governed by a principle peculiar to life. Nor do I mean, by the vital principle, the ſoul of the Stahlians; but that energy which diſcovers itſelf particularly in muſcular contraction; and is evidently different from elaſticity, or any other known power in nature. Its exertions do not depend merely on the intelligent mind; ſince we obſerve them in muſcles cut out from the body, and excited to action by heat, and other irritations. But, though we perceive its action independent of intelligence, it would be difficult to imagine a mind, ſuch as ours, unconnected with this power. Unleſs we could conceive a mind without ideas, or ideas without ſenſations; pleaſure and pain without feeling, or the paſſions relative to theſe without their objects; and, finally, volition without the capacity of action. By muſcular motion alone are we led to the belief of an immaterial principle in animals. And if this was not the only, as well as ſufficient ground of our belief, vegetables, nay minerals, for ought we know, might be poſſeſſed of ſouls full of differently combined ideas, and ſubject to all the variety of paſſions; ſince without this power, and machines like muſcles which it might ſet in motion, they could never diſcover themſelves to our ſenſes. Every man can perceive in his companion the ſtrong emotions which agitate his ſoul; eſpecially where the natural behaviour is not confined by the rules of politeneſs, or rendered perplexing by the complicated influence of ſeveral paſſions. Yet he ſees only the effects of certain changes in the muſcular power; which naturally ſhould lead him no farther than their immediate cauſe. But it ſeems, the connection of theſe changes with certain ſtates of the mind is ſo conſtant and neceſſary, that we paſs from the ſigns of the former directly to the latter.

ON this is founded the ſcience of phyſiognomy, whoſe firſt rudiments may be diſcovered in the unexperienced infant. Nature teaches herſelf thoſe relations, the knowlege of which is neceſſary to our exiſtence; and this, among the others, ſo eſſential to a ſocial being, who in his original ſtate had no arbitrary language. But the ſcience can be greatly improved by obſervation; if we may believe what is told us of the people, who have employed themſelves particularly in this ſort of inveſtigation. The method adopted by one of the moſt eminent phyſiognomiſts in hiſtory deſerves our attention. It is ſaid, that when he wiſhed to diſcover any one's inclinations, he uſed to faſhion every geſture of his body into a perfect reſemblance with him; and then, from the change produced in his own mind, he collected the ſituation of the perſon's whom he imitated. Thus, while by an effort of the will he produced a certain condition of that power, which is the ſource of muſcular motion; he produced at the ſame time the particular frame of mind connected with it. And may we not, in this way, explain the contagion of paſſions, ſo remarkable in many ſpecies of ſenſible creatures? Every one knows how apt we are to catch the geſtures of others; and has ſeen the gaping of a ſingle perſon ſpread itſelf through a whole company. The propagation of convulſive diſorders, among people of delicate and mobile habits, is a noted fact of the ſame kind. And they make it probable, that the motions which accompany the paſſions are communicated to the beholder; and, becoming certain conditions of the ſource of muſcular action, produce, as in the former inſtance, the ſtates of mind with which they are connected.

THE material principle of motion, in animals, appears to be the ſame with that of feeling. The voluntary contraction of any muſcle in the body is rendered impoſſible, by dividing the nerves with which it communicates; and every ſenſation, we know, may be prevented, either by hindering the impreſſion upon our nerves, or by ſtopping the communication of its effect through them to the brain. All our ſenſations are, without doubt, ſo many different ſtates of the mind; but they are the neceſſary conſequences of certain determinate changes in the power we have been conſidering.

AND the faculty of retaining ideas, of comparing, and variouſly combining them, ſeems to bear the ſame relation to the conditions of the common origin of the nerves. It has been weakened, altered, or entirely deſtroyed, by topical and evident affections of this organ. But, when the memory, the imagination, and the judgement, undergo ſuch remarkable changes from diſeaſes, and from material cauſes operating upon the body; muſt we not believe that theſe qualities of mind, like the others we have mentioned, depend upon certain ſtates of the nervous power, and vary with them? It ſeems probable, therefore, that every modification of the ſoul, as far as it relates to the corporeal world, or can become the object of a phyſician's attention, will be found in ſome condition of that energy which belongs to the nervous fibre of animals.

THEY pretend, indeed, that there is no poſſibility of conceiving either the beginning, or the continuance of motion in our machine, except from the action of an immaterial principle. Yet it is certain that the animal motions would never have begun, and would ceaſe immediately, unleſs they were ſupported by the influence of external phyſical cauſes. In the impregnated egg is any activity ever diſcovered, without the application of heat? The ſoul had ſlept for ever, and the machine continued motionleſs, but for the action of this energy. We believe, with the greateſt reaſon, that the brain is the ſeat of the intelligent principle. But in thoſe fœtuſes which are nouriſhed, and arrive at their full growth, without any brain, what ſhall we ſuppoſe to have been the ſource of motion and activity?

We certainly diſcover marks of intelligence in every work of Nature; and of theſe the animal machine appears to be the moſt perfect and exquiſite. Their ſupreme Author has directed, by fixed laws, to the wiſeſt purpoſes, the operation of brute and inſenſible matter. To neglect the inveſtigation of his laws, and refer theſe purpoſes to ſome inferior intelligence, reſembles the ſuperſtition of thoſe idolaters, who adore in the ſun the ſource of all the beneficent changes in Nature. Such notions are the offspring of ignorance; which leads us to derive from a Being of a ſuperior kind, what we cannot explain from the view of any material energy. And they tend to make that ignorance perpetual, by ſetting bounds to the progreſs of the mind in its enquiry after phyſical cauſes.

It is in the contemplation of Nature, ſtruggling with the powers which have a tendency to deſtroy life, that the Animiſts chiefly triumph. But the efforts of the œconomy to re-eſtabliſh its order when diſturbed, ſeem to depend rather on the conſtitution of the machine, than on any endeavours of the intelligent principle. For they do not vary with the condition of the intelligent principle in different animals, but with the ſtate of the machine. And we certainly obſerve, that the *vires medicatrices naturæ* are much more perfect in a *polypus* (whoſe ſhare of intelligence we may believe is not very conſiderable) than they are in a man. Since, while they cure with ſome difficulty a ſmall wound in the latter, they form, from each of the divided pieces of the other, a compleat animal.

It was eaſily perceived that every analogy from the ſenſible world muſt be inſufficient to explain the phenomena of life: and ſo far there could be no miſtake, for the thing reſted on ſimple obſervation. But they drew too haſtily their concluſion, that the phenomena muſt certainly depend on an immaterial cauſe. For as yet phyſicians had given very little attention to that peculiar energy, which reſides in the nerves of animals; and though a material agent does not, as far as our obſervation goes, reſemble any other in nature. Was it then ſurpriſing, that in their attempts to explain operations, which, however ſubjected to the common laws of matter, muſt ſtill be influenced by this vital power, they were ſo often contradicted by experience? They reſembled the ſpeculative mechanic, who, having conſtructed a machine with a view only to certain principles, is diſappointed on trial by the influence of ſome power which had never entered into his calculation.

One is ready to imagine, from what we know of digeſtion, that this proceſs can be explained by the facts which relate to mixture, and to fermentation. Yet an excellent anatomiſt *, who has enquired, by experiment, into the ſtate of this function in living animals, declares that it is not analogous to any chymical operation; and, to mark its peculiar nature, he has given it the name of Animalization. But digeſtion ſeems to be, in this ſenſe, a chymical, and a fermentative proceſs; as it changes the qualities of certain animal and vegetable ſubſtances, in a determinate way, reducing them conſtantly to a matter of the ſame kind. We cannot explain its diſtinct and ſpecific nature, becauſe we are not acquainted with all the powers which concur in the operation. We calculate pretty well the effect of the animal heat, the air, the motion; and, ſince the ingenious experiments of Sir John Pringle, of the ſaliva

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* Mr. J. Hunter.

mixed with our food. The influence of other fluids, which may be preſent in the ſtomach, is more obſcure; and we know ſtill leſs of the effect of the vital power. We perceive, indeed, that nothing favours digeſtion more than a chearful ſerenity of mind; while an afflicting piece of news at once diſturbs it, and ſeems to change the ſtate of fermentation in the contents of the ſtomach: and we know that paſſions of the mind can only affect this function through the nervous influence. The abovementioned ingenious obſerver diſcovered, that the proceſs of animalization was more perfect, and ſooner compleated, in a vigorous animal than in one that was weakened; in a hungry animal, than in one which ſhewed no appetite. But vigour and hunger can only be referred to certain ſtates of that power, which is the ſource of motion, and of ſenſation. It has therefore naturally, we may ſuppoſe, a conſiderable ſhare in this operation. And, as we cannot pretend to imitate its action out of the body, we muſt not expect to find a perfect analogy with digeſtion in any artificial proceſs.

But if thoſe animal operations, which diſcover the greateſt affinity with what is obſerved in the other parts of Nature, are ſtill very different, and ſeem to owe their diſtinctneſs to the nervous influence; is it not ſurpriſing, that the conſideration of this power ſhould have been ſo long neglected by ſyſtematics? The ſimpleſt obſervation muſt have informed them, that ſenſation, and ſpontaneous motion, diſtinguiſh animals from every other kind of being. Was it not, therefore, reaſonable to believe, that in explaining the animal operations, the facts which relate to ſenſation and motion muſt be of principal importance? But they were leſs occupied with examining and comparing the animal phenomena, than with attempts to illuſtrate them by known and obvious facts. Mechanics, and chymiſtry, ſupplied a large field for analogies. Some of their principles were aſcertained; and to men poſſeſſed with the idea of the efficacy of theſe powers, and of theſe alone, their application in the theory of the animal functions appeared to be eaſy, and natural. For the ſame reaſon, that the firſt theory of chemiſtry was taken from the mechanical properties of bodies, the firſt theories in phyſic ſprung from our knowledge of the other parts of Nature; and were either mechanical, or chymical. But the laws of the nervous power could only be determined by attending cloſely to the phenomena of life, and to that relation between them which might allow their being aſſociated under general heads. The labours of the illuſtrious Haller were the baſis of this work; which has ſince been enriched by other obſervers. And in the hands of a profeſſor* eminent for his genius, and his extenſive knowledge of the animal œconomy, it has grown into a ſyſtem: whoſe principles are as true as any in chymiſtry or mechanics, being founded, like them, on the ſure ground of obſervation; and are of far more extenſive application in the theory of phyſic.

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* Dr. Cullen of Edinburgh.

We have ſeen the connection of medicine with the other ſciences, and how naturally its improvement follows their progreſs. We acknowledge ourſelves indebted to philoſophy, for many rational views of the œconomy, as well as for all our knowledge of external agents, the means of life, and fruitful ſource of diſeaſes. Theory was nurſed by it, and grew up under its wings. Mankind ſeem to have an inſtinctive notion of the relation ſubſiſting between every part of Nature; ſo that the view of one of her operations always ſuggeſts ſome opinion concerning another. This movement of the ſoul will often precipitate us into error; but it is conſtant and neceſſary.

What can we reaſon, but from what we know?

WHEN it was believed, that fire and water were Nature's principal agents, and concerned in her various productions, it was eaſily imagined that they exerted an equal influence in the animal œconomy. And on this ground was adopted the notion of hot, cold, moiſt, and dry temperaments, and of their ſeveral combinations. But, like every other hypotheſis, it muſt be ſupported by an appearance of obſervation. The phenomena which occurred to the moſt ſuperficial view; as the evacuation of different fluids in different ſtates of the conſtitution; and the various appearance of the countenance, that ſeemed to indicate a variety in the proportion of the animal fluids; ſupplied this baſis. And thus the terms, Sanguine, Phlegmatic, Choleric, and Melancholic, which carried a more particular reference to the conditions of the œconomy, were aſſociated with the former. The terms of the ancients have deſcended to us, ſo ſanctified by long uſage that we continue to employ them; though, in general, they convey certain collections of ideas very different from thoſe to which they were originally annexed.

When chymiſtry began to make ſome progreſs, and had not yet acquired juſt principles of its own, its adepts believed, through ignorance and enthuſiaſm, that they could diſcover in it the principles of every other ſcience. And as theſe rude philoſophers, from the relation of chymiſtry to the Materia Medica, were particularly connected with medicine; they preſently introduced into its theories the moſt ſtriking phenomena of their art. Every appearance in the oeconomy was traced to ſome ebullition, or effervеſcence; ſome effect of an acid, an alkali, nitre, or ſulphur.

MECHANICAL notions are ſo extremely obvious, their objects ſo familiar to the ſenſes, and concerned in our uſual occupations, that we naturally recur to them firſt for the explanation of any phenomenon. They very ſoon, therefore, obtained a place in medical theories; but they made no extraordinary figure there, until the laws of motion in ſolids and fluids were better aſcertained, and the road of the circulation diſcovered. Then indeed this ſyſtem, with a band of mathematicians proceeding in all the form of demonſtration, grew exceedingly formidable.

OUR attention to electricity particularly, and its conſiderable improvement in the preſent age, have they not contributed towards turning our thoughts to the nervous ſyſtem? For though it is by no means demonſtrated, that the nervous power is the ſame with that which occaſions the phenomena of electricity; and the laws of this power are as independent on any ſuch hypotheſis, as the laws of gravitation are upon the hypotheſis of an etherial fluid; yet the contemplation of ſuch active and ſubtile energies has enlarged our views, and drawn the attention from thoſe principles of mechanics and chymiſtry, to which it was before too ſlaviſhly attached.

Thus medical ſyſtems put on different appearances, according to the different lights which they receive from philoſophy. But theſe reflected rays, too weak of themſelves to diſpel the darkneſs, could only produce indiſtinct, and frequently monſtrous images. It was not till the ſun aroſe in our own hemiſphere, and that ſpirit of obſervation, which has diſtinguiſhed the latter ages of Europe, began to exerciſe itſelf on the animal machine, that we acquired clear and accurate notions. The ignorant ſimplicity of the ancients, the mad whimſies of the chymiſts, and the more ſolemn fooleries of the mathematicians, diſappeared by degrees; and were forced to quit, though reluctantly, their hold on the minds of men. We learned to fix the bounds of thoſe analogies, which we drew from the other parts of Nature; nor was our progreſs ſtopped when the light of analogy failed, and there ſeemed to be an end of all connection of the animal ſyſtem with the reſt of the world. Obſervation ſtill conducted us, in our attempts to collect the laws of the œconomy from a full induction of facts.

THIS ſort of knowledge is ſo valuable, that every endeavour to extend it is meritorious. It will ſhew a laudable inclination, and ſome degree of judgement in the choice of our road, though the ſtate of our abilities, or opportunities, may deny us the praiſe of a conſiderable progreſs. And even when we fail of producing a clear convictoin, it is rare that, in the coliſion of facts, no ſparks are ſtruck out to ſhow a future adventurer his way.

EXPERIMENTS

UPON THE

HUMAN BILE.

THE Bile is ſo diſtinguiſhed among the animal fluids by its active qualities with regard to the ſenſes, and by the peculiar apparatus for its ſecretion, that it ſeems to have attracted, in all ages, the attention of Phyſicians. The Ancients (we muſt acknowledge it in ſpite of our reverence for them) ſaw only a very ſmall part of that chain of cauſes and effects which operate in the œconomy. Was it ſurpriſing then that, in their attempts to explain from this narrow view the whole ſeries of phenomena, they ſhould aſcribe too large an influence to the powers which preſented themſelves the moſt obviouſly to their ſenſes? Theſe were the animal fluids; and more eſpecially the Bile, whoſe properties convey an idea of greater energy, and whoſe frequent appearance in the diſeaſes of their climate led them to ſuſpect every where its action. The chemiſts received and cheriſhed this notion of the importance of the fluids, becauſe their art ſuggeſted various degeneracies to which they were expoſed, each the ſource of ſome active ſubſtance, capable of diſordering the whole machine. But particular Phyſicians have gone farther than ſeemed to be permitted even by the prejudice of ſyſtem. Greulichius attempted to prove, by a variety of miſapplied facts, that the Bile in its natural ſtate is the proper ſtimulus to every function, and the chief miniſter of the great Archæus, and that its degeneracy is the ſource of almoſt every diſeaſe. And, even in our own time of ſounder philoſophy, and more enlarged views of the œconomy, the remarkable changes obſerved in this ſecretion, and their connection with certain diſorders, have perſuaded ſome eminent authors that it has a conſiderable importance in the animal ſyſtem.

If we were better acquainted with the nature of the Bile we might ſpeak with a greater preciſion of its effects. Boerhaave, who has given the tone to medical reaſoning in the preſent age, took it into his head to call this fluid a ſoap; a term he ſeems to have been fond of, and to have applied on other occaſions without a chemical accuracy. The notion does not appear to have been ſuggeſted originally by any enquiry into the compoſition of the Bile, but merely by the uſe which artiſts made of it in removing the ſtains of clothes, or mixing oils with water for the purpoſes of painting and varniſhing; and perhaps alſo by its ancient application in medicine as a detergent. It was convenient to the theoriſt, as it afforded a ready view of the chief intention of nature in preparing this fluid; that it might ſerve as a medium for uniting the oily and watery liquors in the firſt paſſages.

But if this was the origin of the opinion, it ſhould have been remembered that there are other ſubſtances which have no relation to ſoap, and yet are capable of rendering oils miſcible with water. Such are the vegetable mucilages, and the gelatinous animal fluids; to which an obvious quality of the Bile, its viſcidity, might have led them to ſuppoſe it related. Yet ſo great a weight did the authority of Boerhaave give to this fancy, that it has been implicitly received by the moſt eminent phyſiologiſts and pathologiſts of Europe, by Haller and by Gaubius. Nay, the ſanction of experiment is pretended to be given to it, in a paper of the Academy of Sciences, by Monſ. Cadèt; from which we chiefly learn how ſmall a degree of proof is ſuppoſed neceſſary to confirm a belief, already eſtabliſhed in prejudice. The author having been able, by the force of fire, to obtain from the Bile ſome oil, and ſome fixed alkali, immediately concludes that it muſt be a ſoap. With equal reaſon may the milk be called a ſoap, from which we get a much greater quantity of oil, and alſo ſome fixed alkali, according to the experiments of Mr. Beaumè.

THE Theſis of Dr. Ramſay preſented us with a different view of this fluid; but his limited time prevented the ingenious author from completing his enquiry. Indeed, at any rate, as his experiments relate only to the Bile of an animal that ſubſiſts entirely on vegetables, a farther reſearch was abſolutely neceſſary. It ſeems to have been demonſtrated by Reaumur, that other fluids employed in digeſtion differ conſiderably in the animals, which naturally make uſe of different kinds of food. Was it abſolutely certain that the Bile was ſuſceptible of no ſuch variety? Other experiments have been made by foreign authors, of which I have not been able to procure a ſight. But if we may judge from the Synopſis which Dr. Haller has given of thoſe he was acquainted with, they have a good deal of confuſion and uncertainty, and give no ſatisfactory view of the nature of this fluid. It is ſaid to be ſaponaceous, to be reſinous; and amongſt the moſt modern authors there are ſome who pretend to derive its active properties from a portion of iron, which experiment, it ſeems, has detected in it. And thus, while the queſtion of the nature of the Bile is continually recurring to phyſiologiſts and pathologiſts, their anſwers are extremely different; and who ſhall decide among them? If our opinion is to be determined by authority, we ſhall ſtill be at a loſs, for very oppoſite notions are ſupported by names equally reſpectable. Happening laſt winter to employ myſelf in diſſection at an hoſpital in Paris, I found an opportunity of indulging my curioſity, and attempting to remove my doubts. The events of my firſt experiments were communicated to ſome medical friends, who admitted them with much doubt and heſitation, they were ſo different from the received idea. If this is the caſe, I ſaid, their novelty muſt give them ſome value: I will repeat them, and tell them to the world. They may ſerve at leaſt to rouze the attention; and then, in ſuch cities as London and Paris, where there are ſo many able obſervers, and ſuch convenient opportunities of purſuing this enquiry, it cannot fail of being quickly puſhed to the length of giving a clear and accurate knowledge.

THE Reader will not expect, I hope, what is commonly called an analyſis of the Bile. The power of fire has already been employed on this ſubject, by more experienced hands, in the midſt of the conveniencies of a laboratory. The ſtate of a Voyageur, unfurniſhed with any thing like a chemical apparatus, and ſufficiently occupied with other matters, would have been rather unfavourable to ſuch an operation. I have only attempted to throw ſome light on the nature of the Bile, by mixing it with other bodies, and marking the phenomena; which, though a leſs artificial, is frequently a more uſeful method of inveſtigation.

THE Human Cyſtic Bile, the ſubject of the following Experiments, is a brown viſcid liquor, with a ſweetiſh bitter taſte. But theſe qualities are liable to ſome variety, as appears from the accounts of diſſections. In the early fœtus, the Bile is naturally without colour, and without bitterneſs; and, in certain diſeaſes, it has been found in the ſame ſtate. It has ſometimes appeared of a yellow, of a ſaffron,

fron, of a bloody, and of a black colour. I have ſeen it perfectly black, and with ſuch a conſiſtency at the ſame time, as to reſemble common pitch. When it is firſt taken out of the bladder, it has a faintiſh diſagreeable ſmell; but, after being kept ſome time, it acquires a briſker, ſaccharine, not unpleaſant odor, ſomewhat like that of fermenting beer. A gentleman ſaid that he had been ſtruck with the ſame ſmell from milk in a certain ſtage of fermentation; and I remember to have obſerved an odor in rennet-whey that reſembled it very nearly. I do not find that this change has been taken notice of, yet it conſtantly happened in all the Bile which was not putrid before I got it, and was preſerved in a clean and cloſe veſſel. After a longer or ſhorter period, which in ſome caſes has been twelve days, the approach of putrefaction is diſcovered by the exchange of this ſmell, for one reſembling that of rotten eggs.

The fœtor increaſes until it becomes very intolerable.

THE Bile mixes uniformly with water, whether cold or boiling, as well as with milk. But I could not, by means of agitation in a phial, unite it in any degree with oil; for however theſe fluids might be confuſed together during the motion, they conſtantly ſeparated on ſtanding, and there was as perfect a diviſion between them, as there would have been between oil and water.

THE mineral acids have frequently been joined with the Bile; but the phenomena of theſe mixtures have not been ſo much attended to as they ſeem to deſerve. In the common authors many of them are not mentioned, and others are falſely deſcribed. Baglivi, whoſe experiments were likewiſe made upon Human Bile, ſeems to be the fulleſt and moſt accurate in his hiſtory, as far as it extends.

EXPERIMENT I.

STRONG ſpirit of vitriol being poured upon ſome Bile in a phial, produced an inſtantaneous coagulation of it. The coagulum, ſwimming in a clear liquor, was then of a pale colour; but preſently it became green, as well as the liquor about it; and on ſhaking the veſſel the coagulum diſappeared, and there was formed a turbid green ſolution. Some water being poured to this, and the veſſel left at reſt, there fell to the bottom a plentiful green ſediment, the liquor above remaining clear, and of a beautiful green colour. Theſe phenomena were the ſame in every repetition of the Experiment, except that the production of the green colour and turbid ſolution was ſometimes inſtantaneous, without any previous coagulation *.

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* I MET once with ſome Cyſtic Bile which differed from the ordinary appearances of that fluid. It

EXPERIMENT II.

STRONG ſpirit of ſalt, being applied in the ſame manner, did not, that I perceived, coagulate the Bile, but gave at once the turbid green ſolution, and the other phenomena, as in the above Experiment.

It had exactly the colour, and ſoon after its being put into a veſſel acquired the ſweet ſmell of melaſſes, or common treacle. The vitriolic and muriatic acids diſſolved it; yet the ſolution was not green, but brown, and turbid. There was heat produced during both ſolutions, eſpecially during that with the vitriolic acid. On pouring this, while freſh, out of one glaſs into another, and putting ſome hot water into the firſt glaſs, in order to waſh it, I perceived that the water immediately got a fine green colour. The coagula of this Bile formed by the weak acids was not of a greeniſh yellow, but of a duſky brown colour, approaching to black. And the tincture it gave to ſp. vini was not a yellow, but a reddiſh brown, yet quite clear and tranſparent. See Exp.

EXPERIMENT III.

STRONG ſpirit of nitre being poured on ſome Bile, gave the appearance of a thin cake ſuſpended in a fluid. On the ſurface of the cake was ſpread a green circle, with a quantity of bubbles; which Baglivi, who made the ſame experiment, deſcribes in theſe words, *Statim bullæ viridiſcentes, cum telâ veluti cæruleâ natante.* This coloured film diſappeared in a little time, and there remained a turbid brown ſolution. I obſerved that agitation haſtened the eſcape of the green circle, and increaſed the appearance of bubbles on the ſurface.

THE turbid brown ſolution, being ſet by in an open veſſel, was found conſtantly covered with a froth, though it was left perfectly quiet. The brown colour diſappeared by degrees, and there remained a turbid whey-coloured liquor, with a quana quantity of whitiſh ſediment. No heat was applied in this Experiment.

EXPERIMENT IV.

HAVING put a little Bile into ſome nitrous acid, which was pretty ſtrong, without being fuming, I corked the phial, and expoſed it to heat. The veſſel was preſently filled with a flame-coloured elaſtic vapour, which drove out the cork with great impetuoſity. At the ſame time the frothy bubbles, which covered the ſurface of the liquor, diſappeared, and it became more clear and tranſparent. I ſtopped the phial more cloſely, and ſet it again in the heat, where I allowed it to continue for ſome time filled with the flame-coloured vapor. I then removed it from the fire, and I obſerved, that as theſe fumes diſappeared, being condenſed by the cold, and falling back on the liquor, this gradually acquired a deep-green colour.

EXPERIMENT V.

I EXPOSED a mixture, the ſame as in Experiment IV. to the heat, in a phial that was not corked. When firſt ſet down, its ſurface was covered with bubbles, but as the red vapour aſcended, and filled the neck of the phial, theſe diſappeared, and the mixture grew paler and clearer. I afterwards removed the mixture into the cold, where the flame-coloured fumes ſoon vaniſhed, but the mixture never acquired a green colour. It continued clear and tranſparent, and of a permanent yellow colour, though left open and expoſed to the air. There was no froth obſerved on the ſurface of this ſolution, as in Exp. III. nor was there the ſame depoſition to the bottom of the veſſel.

EXPERIMENT VI.

I THEN took the mixture which had acquired the green colour, as has been related in Exp. IV. and expoſed it again to the heat. The veſſel was ſoon filled again with the flame-coloured vapor, which at length drove out the cork. I left it open, and preſently removed it into the cold. The fumes diſappeared, and I found that the ſolution had loſt its green colour, and acquired that of Exp. V. This ſolution continued clear and tranſparent; its yellow colour was permanent in the open air; and there was no appearance of froth upon it's ſurface.

EXPERIMENT VII.

ON the turbid green ſolutions of the Bile formed by the vitriolic, and the muriatic acids, I poured ſome ſtrong ſpirit of nitre. It immediately deſtroyed their green colour, and produced the brown ſolution which it forms itſelf with the Bile (Exp. III.), and this being ſet by in an open veſſel, was affected in the ſame manner as in the Experiment referred to. Pouring ſome nitrous acid on the clear green liquor of the ſame ſolutions, (Exp. I, II.), I obſerved that their green colour diſappeared firſt in a circle at the bottom of the glaſs; but, when I ſhook the veſſel, this change took place at once in the whole liquor.

EXPERIMENT VIII.

THE clear green liquor of the ſolutions I, II. being evaporated to about half their quantity, reſembled very much the turbid ſolutions of the ſame Experiments. Evaporated to dryneſs, they yielded a black paſte, which received and retained impreſſions, and was conſiderably acid. Affuſion of water removed the acidity, and left the black matter, toughiſh between the teeth, perfectly inſipid, and equally inſoluble in ſpirit of wine and in water.

The turbid ſolutions yielded the ſame matter in greater quantity.

The reſiduum from the nitrous ſolution was of a pale yellow colour, and reſembled the coat which whites of eggs leave on a veſſel in which they have been expoſed to heat.

One of the moſt curious circumſtances attending the mixture of the mineral acids with the Bile, is the production of the fine green colour. It is alſo a leading phenomenon, and marks the commencement of a vigorous action of the ſalt upon the fluid. For the Reader has ſeen (Exp. I.) that the vitriolic acid, on its firſt addition to the Bile, ſimply coagulated it; and that the appearance of the green colour was the firſt ſign of any change tending to the ſolution of that fluid. And he will ſee preſently, that the mineral acids conſiderably diluted merely coagulate the Bile; and, being incapable of any farther action upon it, do not produce the green colour. We cannot therefore have any theory of the action of the ſtrong mineral acids upon the Bile, without enquiring into the origin of this colour.

EVERY one knows, that the ſeveral concretions of the Bile are inflammable, and more remarkably ſo than other bodies which ſeem to contain an equal portion of oil. We ſhould expect therefore to find, in this fluid, the principle on which inflammation depends; and which, in all its various combinations, whether it makes a part of oil, of ſulphur, or of any other body, is known to the chymiſts by the name of Phlogiſton.

And as the concentrated mineral acids, eſpecially the nitrous, have a ſtronger attraction for this matter than for any other, we ſhall not be ſurpriſed to ſee them unite with it, on their application to the Bile, and produce thoſe phenomena which accompany their action on the phlogiſton in other caſes.

THE remarkable reſemblance between the ſolutions of the Bile and thoſe of iron in the ſame acids has been uſed as an argument for the colour of the Bile, and the changes it ſuffers from the acids, being an effect of its iron. But the green colour of thoſe metallic ſolutions evidently depends upon the phlogiſton of the iron uniting with the acids; for the nitrous ſolution, when freſh made, and charged with this principle, is of a fine green colour; but as that very volatile matter, which ariſes from the combination of phlogiſton with the nitrous acid, eſcapes, this ſolution changes its colour to a ruſſet-brown. And the muriatic ſolution is at firſt green, but afterwards becomes brown by keeping; and that this change depends upon the gradual loſs of the phlogiſton, appears from the following obſervations *. If the metal be deprived of its phlogiſton, or reduced to a calx, before it is put into the acid, the ſolution is of a brown colour from the beginning: and if you add freſh bits of metal to the ſolution, which at firſt was green, and is become brown by keeping, you reſtore its green colour; which certainly depends on your reſtoring the proper quantity of phlogiſton.

But it would ſeem, from our Experiments, that the green colour of the ſolutions of the Bile is to be explained in the ſame way. For we find (Exp. IV.) that there is in the Bile a conſiderable quantity of the principle of inflammability, which diſcovers itſelf by convert-

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* Dr. Black's Lectures on Chemiſtry.

ing the nitrous acid into the flame-coloured elaſtic vapour. And from attending to the phenomena of the IVth, Vth, and VIth Experiments, it will appear evidently, that the green colour in the nitrous ſolution depends on the union of the phlogiſton of the Bile with the acid. For, when the flame-coloured vapour is confined, and obliged to mix itſelf with the ſolution, the green colour is produced; which does not appear when it is allowed to fly off: and when the green colour has been produced in this way, it is made to vaniſh again, by expelling from the ſolution the flame-coloured vapour.

Having premiſed this view, the phenomena of the preceding Experiments become clear and intelligible. As ſoon as the concentrated mineral acids touch the Bile, they are carried by that force of attraction, which is ſo remarkable between them and the principle of inflammability, to act upon, and diſſolve it.

And, during this operation, the bright green colour is produced, in the ſame manner as it is produced during the action of theſe acids upon iron. The combination of the nitrous acid with phlogiſton is, perhaps, the moſt volatile body in nature; and hence the green colour, which appears during the action of this acid upon the Bile, is extremely evaneſcent. In the open veſſel it flies off almoſt as ſoon as it is formed (Exp. III.); and by the time that the firſt vehemence of the action of this acid upon the Bile is over, the green colour has entirely diſappeared. The frothy bubbles, the *bullæ viridiſcentes* of Baglivi, which ſhewed themſelves on the ſurface of this ſolution, and not of the others (Exp I. II.), did they not indicate the eſcape of this volatile matter? And is not this the reaſon of their being increaſed by agitation, which alſo haſtened the eſcape of the green colour, and produced both theſe effects, by aſſiſting the action of the acid upon the phlogiſton? When the ſolution was expoſed to the fire (Exp. IV.), theſe bubbles diſappeared, and the heat, increaſing the force and quantity of the volatile matter, gave it the viſible form of elaſtic red fumes.

BUT it appears, from Exp. III. that, as in the metals, in the *phoſphorus urinæ*, ſo alſo in the Bile, while a part of the phlogiſton is eaſily and quickly ſeparable, there is another part which adheres more cloſely to the reſt of its ſubſtance. Is it not this part which gives, with the nitrous acid, the ruſſet ſolution; and which at length eſcapes in the open veſſel, though ſlowly and gradually? It was ſome days before the brown colour diſappeared in the nitrous ſolution, and it was all the time covered with a froth, which indicated now I preſume, as before, the eſcape of the nitrous acid volatilized by the phlogiſton of the Bile.

THE green colour of the vitriolic, and muriatic ſolutions is permanent in the open air; which depends, in ſome degree, on theſe acids not being ſo apt to be volatilized, and to fly off with the phlogiſton, as is the nitrous acid. It appears likewiſe from the Experiments (Exp. III.) that the attraction of the nitrous acid for the phlogiſton, or the principle of colour in the Bile, is ſo violent, that it ſeparates it entirely from the reſt of the matter of that fluid. But the vitriolic, and muriatic acids diſſolve, together with the phlogiſton, a conſiderable quantity of a fixed matter, which diſcovers itſelf on evaporating the clear green liquor of theſe ſolutions (Exp. VIII.); and it is, I imagine, the union of this fixed matter which makes the combination of the phlogiſton of the Bile with the abovementioned acids leſs volatile, and leſs apt to fly off. So too when the nitrous ſolution has been expoſed to heat, and loſing its turbid appearance, becomes clear and tranſparent, (which depends moſt probably on the acid's being enabled, by the heat, to diſſolve more perfectly the fixed matter) then the yellow colour becomes permanent in this ſolution, though it be expoſed to the air. And this happens, I ſuppoſe, becauſe the union of the fixed matter repreſſes that volatility which the phlogiſton would otherwiſe give to the nitrous acid. And accordingly we do not diſcover, on the ſurface of this ſolution, that appearance of frothy bubbles which was remarkable in the other (Exp. III.) that had never been expoſed to the heat. And is not this a farther proof, that the frothy appearance depends upon the phlogiſton, or the principle of colour in the Bile, uniting with the nitrous acid, and converting it into an elaſtic vapor?

BUT, if the green colour of the vitriolic, and muriatic ſolutions (Exp. I, II.), depends on the union of the phlogiſton of the Bile with theſe acids, we ſee clearly why the nitrous acid, which has a ſtronger attraction for this principle, and always forms with it a volatile compound, ſhould, as ſoon as it is poured on thoſe ſolutions, ſeparate their phlogiſton, and diſcharge their green colour, as in Exp. VII.

THUS it appears, from all the phenomena, that the action of the concentrated mineral acids upon the Bile, by which they change and decompoſe it, depends on their violent attraction for the principle of inflammability. And as there does not remain, after this action of the acids, any trace of the bitterneſs of that fluid, we may ſuppoſe that it is ſtrictly connected with the abovementioned principle. That this principle is the ſource of the colour of the Bile will be admitted from the general analogy of nature *;

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* Gaub. Patholog. 135. Inflammabile Coloris Sedes. *Dict. de Chymie*, Phlogiſtique.

and ſeems to be demonſtrated by the Experiments related above, and particularly by Exp. III. where the nitrous acid ſeparates entirely the colour of the Bile, and, during this proceſs, is converted by it into an elaſtic vapour. And we ſhall find, hereafter, that the menſtruum, which extracts the colour of the Bile, extracts at the ſame time its bitterneſs *, and that the Bile, deprived of its colour by this menſtruum, no longer gives thoſe phenomena which have appeared to us to depend upon its phlogiſton †.

Having ſeen in what manner the Bile was affected by the mineral acids, I was curious to know the changes it would ſuffer from the vegetable.

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* Exp. XI. † Exp. XIV.

EXPERIMENT IX.

I POURED a little vinegar on ſome Bile, and I obſerved that this fluid was immediately coagulated, its colour changing at the ſame time to yellow, *in vitellinum craſſum*, Bagliv. This has been called a precipitation, but ſurely with great impropriety, ſince there is no ſeparation of parts, no decompoſition, but the whole of the Bile takes the form of a conſiſtent curd. Yet, when authors * talk of the precipitate of the Bile being ſoluble, in part, in ſpirit of wine, they certainly mean this coagulum; ſince what may properly be called a Precipitate, the ſediment of the ſolutions (Exp. I. II.) appears from Exp. VIII. to be in no degree ſoluble in ſpirit of wine.

THERE ſeemed to be a fluid ſqueezed out from the Bile in the inſtant of coagulation,

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* Fordyce, Ramſay, &c.

gulation, for the limpid liquor, which ſwam about the curd, was more in quantity than the acid which had been applied. This liquor had an evident acidity, while the coagulum was conſiderably bitter.

EXPERIMENT X.

JUICE of lemons poured on the Bile produced exactly the ſame phenomena. As theſe Experiments (IX. and X.) are very inconſiſtent with an opinion which has been adopted under the ſanction of Experiment, and made the baſis of ſome important medical theories, I took care to repeat them on the Bile of at leaſt a dozen different perſons. Nor did I ever find any difference in the event, when the Bile was not in a putrid ſtate.

HAVING poured a little juice of lemons on ſome Bile in a large ſpoon, and ſet the mixture by, I found, at the end of twenty-four hours, that the more fluid part had ſtill acidity, while the more ſolid part was conſiderably bitter. I added to it ſome ſalt of tartar, which raiſed a conſiderable effervеſcence, diſſolved the coagulum, and reſtored the brown colour. The mixture had now an intenſe bitterneſs, without any acid, but rather with an alkaline acrimony.

I POURED more lemon-juice on ſome Bile than was ſufficient to coagulate it. I then ſtirred theſe liquors ſtrongly together for ſome time, endeavouring to mix them. I ſet the glaſs aſide; and, after it had ſtood three days, when I came to examine it, I found a ſolid matter of a dark colour at the bottom, and a brown liquor ſwimming at top. The firſt taſte of the liquor was acid, but when it had ſtood a little on the tongue, I found a nauſeous bitterneſs. It coagulated milk, and ſome freſh Bile on which it was poured. The ſolid matter underneath this liquor in the glaſs was moſt intenſely bitter.

THIS coagulum, when authors were poſſeſſed with the notion that the Bile contained a vaſt quantity of oil, has ſometimes been miſtaken for fat. The *amarus adeps* which Schaper obtained from treating the Bile with tartar, and the *ſolidus adeps* which Homberg, by ſhaking the Bile with alum, precipitated to the bottom of the veſſel, could be nothing more than this bitter curd formed by the coagulant power of the acids they employed. Yet Haller has quoted theſe experiments, very ſeriouſly, as proofs of the quantity of oil contained in the Bile, and diſcovering itſelf without the torture of fire.

I NOW returned again to the mineral acids, with an intention to ſee their effect on the Bile, in a ſtate of dilution, when they are brought nearer to the condition of the vegetable acids.

EXPERIMENT XI.

I PUT into three ſeveral glaſſes the three mineral acids, weakened by a large addition of water; and then poured into each glaſs a ſmall quantity of Bile. I obſerved, in each, that as ſoon as a drop touched the acid liquor, it became yellow in its under part, and, being ſpread out into a coherent film, ſupported the upper part of the drop, which was ſtill unchanged in its colour and conſiſtence. But when I ſhook the glaſs, and allowed the liquor to come into contact with every part of the Bile, the whole of it became at once a conſiſtent curd. It reſembled exactly that which was formed by the vegetable acids, except that it was a more compleat yellow, while the vegetable coagulum verged a little towards green.

THE event of this Experiment, compared with that of the firſt, ſecond, and third, may ſurpriſe one who has ſeen, in Dr. Haller's Synopſis, ſuch poſitions as the following: *Cum omni acore minerali cogitur (Bilis) dum ſatis meracus fuerit*; and again, *Eo magis cogitur quo ipſe acor eſt meracior*. But when, without any prejudice of authority, he conſults Nature, and reflects on the phenomena, the event of this Experiment will appear to have been ſuggeſted by the former. The concentrated mineral acids, at leaſt the vitriolic and the nitrous (Exp. I. III.), coagulated the Bile as ſoon as they touched it; and I have endeavoured to prove, that the remarkable appearances which accompanied, or followed this effect, depended on the action of theſe acids on the phlogiſton of the Bile, in conſequence of their vehement attraction for that principle. But it is known that the vegetable acids, in their common ſtate, have comparatively very little of this attraction; and that the mineral acids loſe much of its force when they are combined with a large proportion of water. We ſhould expect, therefore, on applying the vegetable, and diluted mineral acids to the Bile, to ſee their coagulant effect quite pure, and unmixed with thoſe phenomena, which marked the ſtrong action of the concentrated acids upon the phlogiſton of the Bile, in the firſt ſet of Experiments.

EXPERIMENT XII.

I POURED a little Bile into ſome ſpirit of wine, and I perceived that it was inſtantly coagulated; but as it was tending to the bottom, the ſpirit neareſt it grew yellow, and this yellow colour was preſently diffuſed over the whole liquor. There fell to the bottom a browniſh corrugated concrete, and the ſpirit had extracted, together with the yellow colour, a ſweetiſh bitter taſte.

EXPERIMENT XIII.

I SET ſome Bile to evaporate in a common ſtove; and when I came to examine it, I found in the bottom of the veſſel a quantity of hard brittle flakes, reſembling aloes extremely, both in appearance and taſte. This matter, put into water, gave it a turbid brown colour, and an intenſe bitterneſs. An acid poured upon the watery infuſion, cauſed a plentiful precipitation of browniſh flocci, and rendered it clear and tranſparent. The ſame matter taken out of water, and put into ſpirit of wine, gave it a deep brown tinge, and ſweetiſh taſte, without much bitterneſs. It was not entirely ſoluble in either; but the cauſtic alkali diſſolved it perfectly into a brown viſcid liquor. From comparing the above phenomena with thoſe of the coagulum of the Bile, in the ſame circumſtances, it ſeems probable that the Bile was coagulated by the heat employed for its evaporation.

After viewing theſe Experiments, I could not help enquiring what that was in the Bile, which rendered it coagulable by all the acids, by ſpirit of wine, and apparently by heat * ? Can it be any other than that animal matter, which, in the blood, in the milk, in the egg, and everywhere diſcovers itſelf by the ſame quality ? The colour, the

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* A piece of a human ſtomach having been previouſly well waſhed, was infuſed in cold water twelve hours. Some of the infuſion, mixed with the Bile, produced the appearance of a number of little yellow ſpecks, which, ſubſiding to the bottom, formed a ſediment that would not mix again with the Bile, nor with water. I had no opportunity of repeating this Experiment.

inflammability, and the bitterneſs of the Bile had appeared to be connected with a part, which gave plain indications of an abundant, and an evolved phlogiſton; and I was tempted to believe that its viſcidity, and its diſpoſition to coagulate depended on a true lymph. I was ſtruck with the analogy between the blood and the Bile. In both there ſeemed to be a colouring matter, united with a coagulable, and with a more watery fluid which ſeparates on concretion. But the union of theſe ſeveral parts appeared to be more perfect in the Bile than in the blood; as we ſhall endeavour to ſhow when we come to compare theſe fluids. And this I imagined was the reaſon why we never ſaw any ſpontaneous ſeparation of the coagulable from the colouring matter of the Bile, and had never, therefore, been able to demonſtrate the exiſtence of the former.

But as theſe parts appeared to have different chemical relations, I thought that it might be poſſible to ſeparate them entirely. Spirit of wine, while it coagulated the Bile, extracted its taſte and colour; but not perfectly. The action of ſtrong ſpirit of nitre upon the colouring matter of the Bile was much more violent, and ſufficient to ſeparate it altogether; but then it broke down the texture of the coagulable part. Yet the ſame acid, when weakened, ſimply coagulates the Bile. Thinking of this, I determined to try the effect of theſe two bodies combined in *ſp. nitri dulcis.*

EXPERIMENT XIV.

I POURED a very ſmall quantity of Bile into a phial of this liquor, and I got a bright ruſt-coloured tincture, with a ſweetiſh, rough, bitter taſte; at the bottom of which reſted a coagulum perfectly white. When the ſpirit was poured off, and the coagulum put into water, it reſembled exactly thoſe polypous concretions which are ſometimes found in the heart, when they have been well cleaned from any adhering red globules *.

EXPERIMENT XV.

A BIT of this coagulum being thrown into ſpirit of wine, did not communicate any thing to it, nor was it changed itſelf by the ſpirit, except in being rendered ſomewhat more criſped.

EXPERIMENT XVI.

SOME of the ſame matter, being put into a ſolution of cauſtic alkali, was readily and entirely diſſolved by it. This ſolution was a little viſcid, and had a ſlight yellowiſh tinge. An acid added cauſed a plentiful precipitation to the bottom,

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* An extemporaneous compoſition of three parts *ſp. vini*, with one of *aq. fortis*, extracted perfectly the colour of the Bile, leaving a pure white coagulum. This tincture was tranſparent, and of the colour of the former; but it grew paler by keeping, and at length colourleſs.

bottom, which had the floccous appearance.

EXPERIMENT XVII.

A BIT of the ſame coagulum thrown into ſpirit of ſalt, was ſlowly diſſolved; and the ſolution was opaque, with a bluiſh caſt, which was however ſcarcely perceptible.

THE ſuſpicion of a coagulable lymph in the Bile, which had been ſuggeſted by the former Experiments, ſeems to be carried by the preſent to the length of a clear conviction. The colouring matter ſpread over it, though it could not deſtroy its chemical relations, concealed it from our ſenſes. But, in the XIVth Experiment, this veil being removed, the coagulable lymph diſcovers itſelf to the eye. It muſt, however, be remembered, that if the quantity of Bile is too large in proportion to the ſpirit, the whole of its colour will not be extracted, but ſome tinge will remain on the coagulum.

As this part of the Bile, when ſeparated from the colouring matter, is not in the ſmalleſt degree ſoluble in either ſpirit of wine or water, it appears to be of the ſame nature with that which was obtained from (Exp. VIII.) the ſolutions of the Bile in the mineral acids, by evaporation. We have already obſerved, that theſe acids, in a concentrated ſtate, decompoſe the Bile; and, as it appeared before that they acted upon, and ſeparated its phlogiſton, ſo we perceive now that what remains is the coagulable matter, ſomewhat altered indeed by the violence of that action.

BUT the Experiments XV. XVI. XVII. ſerve to ſhow, that the coagulable matter of the Bile, while it has all the ſenſible qualities of the true lymph, is alſo affected in the ſame manner by thoſe chemical relations, which are ſaid to be moſt characteriſtic of that fluid *.

WE ſaw before, that the part of the Bile which was not ſoluble in ſpirit of wine, was changed by it into a firm concrete; and it appears, from Exp. XV. that when this part is ſeparated from the reſt, and coagulated, the coagulum becomes more criſped in *ſp. vini*; and from theſe facts, as well as from Exp. XXII. we may believe that *ſp. vini* is one of the ſtrongeſt coagulants of the Bile, as it is of the coagulable lymph. It ſeems therefore a little extraordinary, that we ſhould meet with the following obſervation in Dr. Haller's account of the Experiments, ——*Neque bilem coit (ſpiritus vini) niſi aliquando debiliter.*

THE vegetable acids, we have proved already, do not decompoſe the Bile; and the reaſon of this difference between their operation, and that of the concentrated mineral acids, appeared to be the inferiority of their attraction for the phlogiſton of this fluid. The coagulum of the Bile, formed by the vegetable acids, is ſtill therefore a combination of the colouring matter of this liquor with its lymph; and it is this ſubſtance which we ſhall next examine.

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* Butt. Theſ. de Sanguine.

EXPERIMENT XVIII.

THE concentrated vitriolic, and muriatic acids, being poured upon the coagulum, diſſolved it; and produced the fine green colour, and the ſame ſort of ſolutions exactly, which they form with the pure and unaltered Bile (Exp. I. II.). The nitrous acid gave immediately the turbid brown ſolution, Exp. III.

EXPERIMENT XIX.

Some of this coagulum being thrown into *ſp. nitri dulcis*, a quantity of bubbles were ſeparated from it, and it was buoyed up to the ſurface of the liquor; where it continued to give out bubbles, while the ſpirit extracted from it a fine green colour. Then it fell to the bottom, perfectly white, with all the appearance of a pure coagulated lymph.

EXPERIMENT XX.

Cold water poured upon the coagulum, extracted from it a ſweetiſh bitter taſte, and a greeniſh yellow colour, and got a viſcid turbid appearance. The pieces of coagulum aroſe at firſt to the top, and afterwards ſubſided to the bottom. This infuſion, after ſtanding ſome time, was found covered with a white ſcum reſembling animal fat.

EXPERIMENT XXI.

THE ſame coagulum put into ſpirit of wine, gave it a deep green colour, and a ſweetiſh bitter taſte, and became hard and criſped.

EXPERIMENT XXII.

SOME of the coagulum, which had remained for ſome time in water, and had thus become ſoft, and acquired a mucous conſiſtence, being put into ſpirit of wine, gave it a green tinge, and became firm and corrugated. A bit which had been in ſpirit of wine, being thrown into water, grew ſofter, but was not otherwiſe affected, nor did it give to that fluid either colour or taſte.

EXPERIMENT XXIII.

Upon ſome of this coagulum, which had been in both water and ſpirit of wine, and had imparted to each as much as it was capable of yielding, I poured a little vitriolic acid. The veſſel being placed in a gentle heat, was preſently filled with a white ſmoke, which, from its ſtrong peculiar ſmell, appeared to be the volatile, ſulphureous acid. There remained in the bottom of the veſſel a very dark-coloured viſcid ſolution.

EXPERIMENT XXIV.

The coagulum being put into a ſolution of cauſtic alkali, was perfectly diſſolved by it. Its yellow colour was changed at the ſame time to a brown; and thus the ſolution, being viſcid, reſembled very much the Bile before it was coagulated. Spirit of vitriol efferveſced ſtrongly with this ſolution, and precipitated to the bottom a quantity of dark green ſediment. And this liquor, being afterwards evaporated, yielded the ſame kind of reſiduum as the ſolution of Bile in ſpirit of vitriol (Exp. VIII.).

It appears, from theſe Experiments, that the colouring matter of the Bile is affected by the ſame relations in the coagulated fluid, as before the addition of the vegetable acid. It gives, with the concentrated mineral acids, thoſe phenomena which depend upon their attraction for its phlogiſton. It is perfectly extracted by *ſpiritus nitri dulcis*, and leſs completely by ſpirit of wine. And we perceive now that it yields itſelf to water likewiſe, by ſimple infuſion. As far as we could judge from our little Experiments, it ſeemed that the ſweetneſs and bitterneſs of the Bile were almoſt equally well extracted by ſpirit of wine, and by water, but that the colour yielded itſelf more completely to the former liquor.

YET the colouring matter appears to be ſomewhat changed by the action of the vegetable acid, for the colour of the coagulum is different from that of the original Bile; and ſo is the colour of the extracts made from theſe two ſubſtances by *ſpiritus nitri dulcis*, and by ſpirit of wine, Exp. XIX. XXI.

WHATEVER this change is, it ſeems to approach the colour of the Cyſtic Bile to that of the Hepatic; and as the brown colour of the Cyſtic is brought back by the addition of an alkali, one might be inclined to think that this colour depended on an alkaline nature acquired by the Bile during its ſtagnation in the gall-bladder. And the other chief difference of the Cyſtic Bile from the Hepatic, being, it is ſaid, the greater bitterneſs of the former fluid, this ſuſpicion might be ſtrengthened by an obſervation of Baglivi. He found that, on the addition of a fixed alkaline ſalt to the Bile, *amarities ejus nimium aucta vomitum præ amaritie vehementem ſtatim movebat* *. But it muſt certainly be difficult to determine the difference of force between two ſenſations, which are both extremely intenſe, and exceedingly diſagreeable. I tried it, and I could only ſay that the alcaline acrimony made the taſte of the Bile, if poſſible, ſtill more nauſeous. But I fancy that Baglivi's Italian ſenſibility magnified exceedingly the force of theſe diſagreeable impreſſions. For he ſays, in another place, that, ſpirit of ſalt being added to the Bile, he found, in the mixture, *Ingrata amarities quæ parum guſtata veluti vomitum ciebat.* This acid, diluted, certainly does not increaſe the bitterneſs of the Bile (Exp. XI.), and when it is applied in a concentrated ſtate, it deſtroys entirely that quality (Exp. VIII.). Yet Dr. Haller, from this remark of Baglivi, and from ſome other authority, aſſerts the very oppoſite fact, *Si idem ſalis ſpiritus meracior fuerit utique Bilem in offam coagulat. auget idem amarorem.* If I was not deceived by my ſenſes in the Experiments already related, here are two affirmations in a breath, which are directly contrary to the truth; for, the ſtronger acid diſſolved the Bile, while the weaker only coagulated it; and the ſtronger acid, far from increaſing the bitterneſs of the Bile, made it diſappear entirely. Theſe reflections do not affect Dr. Haller, who, in delivering the obſervations of others, is certainly not accountable for their inaccuracies.

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* Baglivi, Experimenta de Bile humanâ capta.

One cannot decide whether the Cyſtic Bile is alkaline or not, by the common experiment on the purple vegetable infuſions. For, when I poured into diluted ſyrup of violets ſome pure Bile, and ſome Bile containing ſalt of tartar, the change of colour they produced was nearly the ſame, and in neither could it be called a green.

THE cauſtic alkali, being the beſt diſſolvent of the coagulable part of the blood *, diſſolves moſt perfectly the coagulum of the Bile, which ſeems to conſiſt chiefly of that matter (Exp. XIV. XXVI.). But, as this mixture effervesced ſtrongly with an acid (Exp. XXIV.), we muſt ſuppoſe that there is fixed air in the Bile, by which the alkali was rendered mild, and capable of effervеſcence. But is it from this notion that we are to explain the extraordinary appearance in Exp. XIX.; where the coagulum mounts at firſt to the top, and, after giving out a number of bubbles, ſinks again to the bottom; its ſpecific gravity being increaſed, perhaps, by the loſs of its fixed air? And, in Exp. XX. we obſerv-

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* Butt. Theſ. de Sanguine.

ed ſomething analogous to this appearance, for the coagulum aroſe at firſt to the top of the water, and afterwards ſubſided to the bottom; which might depend upon the ſame circumſtance. Yet, what is very remarkable, during the ſolution of the colouring matter of the uncoagulated Bile in *ſpiritus nitri dulcis*, there was no ſuch phenomenon (Exp. XIV.). How did the vegetable acid give occaſion to this difference?

THE coagulum becomes firmer in ſpirit of wine, and gets a mucous conſiſtence in water (Exp. XXII.); and theſe are the changes which Dr. Butt obſerved to happen to the coagulable lymph in the ſame circumſtances, and are to be explained therefore from the preſence of this matter in the Bile.

THE dark coloured ſolution, which ſpirit of vitriol forms with this coagulum, after the greater part of its colouring matter has been abſtracted by water, and by ſpirit of wine (Exp. XXIII.), ſeems to correſpond exactly with the ſolution of the coagulable lymph in this acid, as it is deſcribed by the ſame author. It produces nearly the ſame kind of ſolution with white of eggs. Whether the ſulphureous acid, which aroſe during the ſolution, depended on the action of the vitriolic acid upon ſome remains of the colouring matter, or upon a decompoſition of the lymph of the Bile, I ſhall not pretend to determine.

EXPERIMENT XXV.

THE ſeveral extracts of the colouring matter of the Bile in *ſpiritus nitri dulcis*, and ſpirit of wine mixed uniformly with water into a clear tranſparent liquor. Nor did they ſuffer any change from the addition of an acid. But an alkali being added to the clear ſolution in *ſpiritus nitri dulcis* (Exp. XIV.), it grew turbid, and there fell to the bottom a large white floccous ſediment. But the colour of the ſolution was rather deepened.

EXPERIMENT XXVI.

I POURED, on the ſame ſolution, ſome of the alkali prepared for making Pruſſian blue. There was precipitated a quantity of white flocci, as in the former Experiment, which ſhewed no tinge of blue.

EXPERIMENT XXVII.

THE ſame alkali being added to the ſolution of the pure coagulable matter in the muriatic acid (Exp. XVII.), gave a precipitate which had exactly the ſame appearance, but was in much greater quantity.

EXPERIMENT XXVIII.

I MIXED ſome powder of galls with the ſolution of the colouring matter in *ſpiritus nitri dulcis*, and it did not, that I perceived, produce any remarkable change of colour.

EXPERIMENT XXIX.

THE ſame powder was put into the clear green ſolution of the Bile in the vitriolic acid (Exp. I.), and I did not obſerve that it produced any ſuch alteration of colour, as one would expect in a ſolution of iron.

MONS. DURADE of Geneva has aſſerted, in his ingenious treatiſe upon nutrition, which obtained a prize from the Royal Academy of Berlin, that iron is the material cauſe of the colour of the Bile *. This metal, or the principles of its compoſition, is ſo generally diffuſed through Nature, that we are not ſurprized to meet with it in animals. It has been diſcovered in human bones, in calculous concretions, where it ſeemed to reſt idle and inactive; but when it ſhewed itſelf in the animal fluids, we imagined that it had an important part to play in the œconomy. I did not repeat the Experiment on which Monſ. Durade founds his opinion; for, as he obſerves that the phenomena are not ſtriking, and are ſlow in appearing †, I thought that perhaps ſome degree of prepoſſeſſion was neceſſary, in order to perceive them. But the tincture in *ſpiritus nitri dulcis* being a very perfect extract of the colouring matter of the Bile, it ſeemed a proper ſubject for trying the truth of this notion. The Reader muſt determine whether the means employed were not ſufficient to have detected the iron, if it had been preſent, in the form and quantity required to produce the effects which are aſcribed to it. Mr. Margraaf obſerved, in the gall-ſtone of an ox, after he had calcined and treated it with ſpirit of vitriol, and the alkali prepared for making Pruſſian blue, ſome ſlight marks of a mixture of iron *. But it appears, from his manner of expreſſing himſelf, that the urinary calculus, the bones of a ſheep, and the human ſcull, gave yet more evident tokens of their containing iron. We cannot ſuppoſe, therefore, that the iron had any relation to the colouring matter of the Bile; ſince it is chiefly in this matter that it differs from thoſe other animal ſubſtances which

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* La Cauſe Materielle de ſa Couleur. *Traité ſur la Nutrition.*

† Ibid. p. 119.

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* Opuſc. Chym. tom. ii. p. 64. "Ont a peine donne quelque indice obſervable," &c.

furniſhed a ſtill greater quantity of the metal, while it reſembles them exactly in its coagulable part.

THE precipitate, from the ſolution of the colouring matter of the Bile (Exp. XXVI.), was ſo perfectly ſimilar to that which was obtained by the ſame means from the ſolution of the pure coagulable matter, that I muſt believe them to be of the ſame nature. And if this was the caſe, we perceive how intimate the union is between theſe two matters; ſince, by means of that, *ſpiritus nitri dulcis* becomes capable of diſſolving a portion of the coagulable matter, which otherwiſe it could have no tendency to do, as it is one of the ſtrongeſt coagulants. One is inclined to believe, from the ſame view, that the coagulable matter makes the greater part of the compoſition of the Bile; and that the colouring principle, as was ſuggeſted by the firſt ſet of Experiments, is of an extremely ſubtile nature.

ture. The moſt remarkable qualities of the Bile appear to be connected with it; but throughout the world a great activity is always found united with a proportionable ſubtlety; and Nature animates the groſſer kinds of matter by powers whoſe fineneſs eſcapes our ſenſes, though we perceive evidently their operation. That principle to which the metals owe their colour, ſplendour, ductility, and every characteriſtic quality; to which the moſt active parts of vegetables, their eſſential oils, owe their peculiar and diſtinguiſhing properties, we only diſcover by the univerſal effects which it produces in the bodies it unites with. We are informed, by theſe effects, that it is preſent in the Bile; and apparently, from its phenomena with the mineral acids, in a ſtate ſimilar to that in which it is found in the metals; where, as it is not fettered with a variety of attractions, it has more of theſe to ſatisfy, and is a ſource of more active qualities in the body with which it is combined.

In conſidering the Bile as an agent in the œconomy, it is particularly important to know its relation to putrefaction. This fluid is employed ordinarily in the paſſages where fermentations, approaching in their progreſs very near to putrefaction, are continually going on. It is ſometimes effuſed there in extraordinary quantities; and frequently it paſſes the limits which Nature ſeems to have appointed it, and mixes with the general maſs of fluids.

The opinions entertained on this head are as different as the circumſtances to which they owe their origin. Some authors were ſtruck with the analogy of the Bile to the vegetable bitters, and believed, with Gliſſon and Baglivi, that Nature had provided, in this fluid, an antiſeptic balſam. There are others, and among them Boerhaave and Senac, who, chiefly from preconceived notions of the nature of diſeaſes, imagine that the Bile is extremely prone to putrefaction. Nor do the obſervers ſeem to be much better agreed than the theoriſts. Dr. Haller has quoted from M. Gaber an experiment to prove that the Bile begins to ſtink in a cold place, within two hours after death. And this ſeems to have perſuaded him, that the Human Bile is a very improper ſubject for experiments, as we may be deceived by phenomena which are merely the effects of putrefaction. If M. Gaber's experiment is admitted as concluſive, Dr. Haller's comment is certainly juſt, and I may be ſuppoſed to have miſtaken, through the whole courſe of theſe Experiments, a putrid fluid for one that ſeemed to be nearly in its natural ſtate. But when I find that Bile taken out of a body which is yet warm, and Bile which has lain in the bladder three or four days after death, have exactly the ſame properties, and, particularly, are both firmly coagulated by the vegetable acid, I am inclined to conſider M. Gaber's caſe as ſomewhat ſingular. We know, that the effect of putrefaction upon the coagulable animal fluids, is to diminiſh, and gradually deſtroy their diſpoſition to coagulate. And can we ſuppoſe that this cauſe has been operating for ſome time, without producing, in the ſmalleſt degree, its conſtant and neceſſary effect?

THERE is reaſon to believe, that the Cyſtic Bile may vary in regard to this circumſtance in different ſubjects. It will probably be more putreſcent, where the general maſs, from which it is ſeparated, is farther advanced in the ſeptic degeneracy. And it is beſides expoſed to particular cauſes, which may influence this proceſs; as the time of its ſtagnation in the bladder, and the ſtate of the vapour in the communicating cavities, which is ſometimes quite putrid very ſoon after death. It may happen, therefore, that the Bile ſhall become putrid very ſoon after death; but generally, as I have already obſerved, there is a fermentation, or at leaſt a ſpontaneous change of qualities, which precedes this ſtage, and is diſtinguiſhed by the production of the ſaccharine odour. The ſenſes diſcover accurately enough when this terminates in putrefaction, by the exchange of an agreeable enough ſmell, for one that is fetid and diſguſting. And then only do our Experiments ſhew ſuch a change in the nature of the Bile, as might be expected from a beginning putrefaction.

EXPERIMENT XXX.

THE concentrated vitriolic acid being poured upon ſome putrid Bile, diſſolved it immediately, with ſome violence and production of heat, into a viſcid black liquor. Water was added to this ſolution, which then acquired a dull green colour, and continued always turbid, though it was left perfectly quiet. This ſolution being evaporated, gave the ſame kind of reſiduum as the ſolution Exp. I.; only that it ſeemed to have leſs tenacity.

EXPERIMENT XXXI.

THE mineral acids diluted coagulated the putrid Bile. But the coagulum was rather of a ſaffron than a yellow colour (Exp. XI.); and ſo weak and brittle, that, on the leaſt agitation, it broke to pieces, and gave the appearance of a turbid ſolution.

EXPERIMENT XXXII.

THE vegetable acids poured upon the Bile did not give to the whole the form of a conſiſtent curd (Exp. X.), but produced a number of ſmall broken curds; nor was the thinner liquor clear and limpid, but turbid, yellowiſh, and without acidity. I obſerved that the putrid Bile, from the addition of the acids, got an odour, which approached very nearly to that of rancid bacon.

EXPERIMENT XXXIII.

Some putrid Bile being put into ſpirit of wine, gave to this liquor a deep brown or black colour, and an intenſely bitter taſte. The precipitate to the bottom was made up of a number of broken pieces, and the ſpirituous extract was not clear and tranſparent, but viſcid and opaque. It gave to water an opaque yellow colour, with conſiderable bitterneſs. Some vitriolic acid being added to this mixture of the ſpirit and water, rendered it turbid; and there fell to the bottom a quantity of brown flocci.

EXPERIMENT XXXIV.

SOME of this Bile was evaporated by gentle heat to the conſiſtence of a ſoft extract, and had then a moſt intenſely bitter taſte. When it was mixed again with water, a part of it ſubſided on ſtanding, which required agitation to keep it united with the water. I cannot ſay that I was ſtruck with the ſmell of muſk in any of theſe Experiments.

EXPERIMENT XXXV.

SOME putrid Bile being joined to a mixture of bread and water, gave to it its own peculiar fetor. But this mixture being ſet to ferment in a heat between 90° and 100° Fahr. ſoon loſt this fetor, and acquired a ſtrong empyreumatic odour, like that of burnt feathers, which continued in it for a long time.

It appears, from theſe Experiments, that the coagulability of the Bile is diminiſhed, as we ſhould expect, by putrefaction. It even becomes miſcible in a certain proportion with ſpirit of wine; diſcovering itſelf by the viſcidity which it communicates to the ſpirituous tincture of the putrid Bile, as well as by the precipitation formed from the tincture by an acid; neither of which were obſerved in the ſame circumſtances of the ſound Bile. With reſpect to the ſenſible qualities of this liquor, as there is no mention made of the ſweet taſte in the laſt Experiments, I preſume that its principle was decompoſed, and deſtroyed by the previous fermentation. But the bitterneſs of the Bile is ſo far from being diminiſhed by the beginning putrefaction, that it ſeems even to be augmented by it; at leaſt the ſpirituous tincture of the putrid liquor was more intenſely bitter than the ſame preparation of the Bile in a ſound ſtate. It appears, therefore, that the bitterneſs of the Bile reſiſts the effect of putrefaction in changing the qualities of bodies, and continues unaltered when the coagulable matter has proceeded far in its degeneracy. It is not improbable then that this quality in the Bile, as well as in other bodies, is connected with an antiſeptic power, though it cannot entirely prevent putrefaction in a matter that, like the coagulable lymph, is peculiarly diſpoſed to it; and in its long courſe to reach the biliary pores, as well as during its ſtagnation in the gall-bladder, is ſubjected in a ſingular manner to the animal powers which tend to induce this proceſs.

WHEN the Bile has been coagulated by the vegetable acid, it is no longer miſcible with water (Exp. XX.), but it communicates to this fluid its taſte and colour, together with a portion of its coagulable matter, ſufficient to give to the infuſion a degree of viſcidity and opacity. If the bitter of the Bile is really antiſeptic, and the putreſcency of this fluid depends on the coagulable lymph, which ſeems, from our Experiments, to make the greateſt part of its ſubſtance, we may expect to find that the infuſion of the coagulum (Exp. XX.) is more antiſeptic than the original Bile; ſince it contains the bitter, together with a ſmaller proportion of the coagulable matter.

EXPERIMENT XXXVI.

INTO each of three ſeveral phials, which I ſhall diſtinguiſh by N° 1, 2, 3, I put an ounce of raw beef. To the firſt I added water only; to the ſecond an equal quantity of a light infuſion of the coagulated Bile in water; to the third the ſame proportion of water, with two tea-ſpoonfuls of Bile. Theſe mixtures, being cloſe ſtopped, were expoſed to a heat between 90° and 100° Fahr. Examining them twenty-four hours after, I found, in N° 2, and 3, that ſweetiſh, ſprightly ſmell which one perceives in fermenting mixtures; and, in N° 1, a ſtrong odour of ſpirit of lavender. This ſurpriſed me, till I recollected that the cork of this mixture, being an old one, had probably been uſed for ſtopping a phial containing ſpirit of lavender, ſome portion of which adhering, the odour had been exalted, and diffuſed through the mixture by the fermentation. At the end of four days, during which time the lamp of the furnace had been twice allowed to go out, but the mixtures were never quite cold, I took them out, and placed them in a chamber, the heat of which was generally near 60₀ Fahr. I examined them every day, and about eight days afterwards I obſerved, in N° 3, a peculiar ſmell, which reminded me of a rotten melon. But N° 1, and 2, remained ſweet about a month longer, the former ſmelling ſtrong all the time of ſpirit of lavender. At length N° 2. acquired the ſame fetor exactly, which had been obſerved in N° 3; and N° 1. began to ſtink ſoon after.

EXPERIMENT XXXVII.

I CHOSE three phials of the ſame ſize, and put into each half an ounce of raw mutton; to N° 1. I added ſeven tea-ſpoonfuls of water; to N° 2. ſix tea-ſpoonfuls of water, and one of Bile; to N° 3. the infuſion of a tea-ſpoonful of Bile, coagulated by the vegetable acid, in ſeven tea-ſpoonfuls of water. Theſe phials were corked, and left in a room which had a conſtant fire in it. Two days after, Tueſday the 24th of March, the mixture N° 1. had acquired an evident fetor; and, in N° 2, I obſerved that ſweet ſmell which precedes the putrefaction of the Bile. On Thurſday the putrid ſmell was to be perceived in N° 2; but N° 3. continued ſweet. By Sunday this mixture had alſo acquired a beginning fetor.

EXPERIMENT XXXVIII.

I REPEATED the ſame Experiment, and joined to N° 1, 2, 3, another mixture (N° 4.), containing, together with the meat and water, a tea-ſpoonful of lemon-juice. I obſerved, in N° 1, a ſtrong acid odour, like that of the ſweat of ſome people, which preceded its putrefaction. It ſtunk before there was any perceptible change in the other mixtures. One of the phials happening to break at this time, I took out their corks, and let them all ſtand open. No 2. and 3. acquired the putrid fetor ſooner than in the former Experiment, but in the ſame order;

der; Nº 2. beginning firſt to ſmell; Nº 4. kept the longeſt ſweet. It was diſtinguiſhed from the other mixtures by its pale white colour, while the others had a florid bloody appearance. But, when Nº 4. began to ſtink, it loſt its white colour, and became florid alſo. The ſurface of this mixture was covered with a mould which I did not perceive in any of the others *.

It has been obſerved, that the milk of carnivorous animals, when they were fed on meat and water only, was ſtill aceſcent, and to explain this fact, it has been imagined, that the powers of ſecretion were capable of reproducing the vegetable nature in animal matter. But it appears,

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* This, I believe, might be a reaſon of its keeping longer ſweet; for, in another Experiment, when this mould was prevented, by frequent agitation, the mixture with the acid, and that with the infuſion of coagulated Bile, began to ſmell about the ſame time.

from the laſt Experiment, that a mixture of lean mutton and water ſimply, paſſes through the acetous ſtage of fermentation before it putrefies. And it is perhaps on this account, that a diet of long-kept ſalted meat has ſuch pernicious effects upon the conſtitution, it being moſt probably incapable of this fermentation. The uſe of freſh butcher-meat is found to be very advantageous to ſailors, who have become ſcorbutic by a long courſe of ſalted meats, and to have an effect ſimilar to that of freſh vegetables.

BUT, with reſpect to the chief object of theſe Experiments, there is one difference among them which I ſhall not pretend to explain, becauſe I do not know whether it will be found to be conſtant, or merely accidental. It ſeemed as if the application of a heat, in the beginning, ſufficient to excite a briſk fermentation, had enabled both the Bile, and the infuſion of its coagulum, to retard longer the ſeptic proceſs. But this, I think, may be fairly deduced from all the Experiments, that the Bile, far from being ſo extremely putreſcent as many have imagined, is rather antiſeptic; and that, when it has been coagulated by the acids, it imparts to water a ſtronger antiſeptic power than we obſerve in the pure and unaltered Bile. The Bile employed in Exp. XXXVI. had lain, to my knowledge, three days in the dead body; and when the gall-bladder was taken out, there was a very offenſive ſmell in all the abdominal *viſcera*. Yet this fluid, being poured into a phial, and cloſely ſtopped, acquired a ſweet ſmell, which continued ſome days before the putrid fetor began. And we find, from the Experiment, that it had a greater effect than ſo much water in retarding putrefaction, and in making it leſs offenſive. But the watery infuſion of the coagulum being more antiſeptic than the Bile, muſt be much more ſo than mere water.

THIS antiſeptic principle of the Bile cannot reſide in the part to which it owes its coagulability; and which appears to be exactly analogous to the lymph of the blood. It is probably connected with the bitterneſs of this fluid, and is like that, a quality of the colouring matter. And thus are we perſuaded, that the authors who, merely from conſidering the bitterneſs of this animal liquor, imagined in it an antiſeptic power, were not deceived by the analogy of Nature. But as they were ignorant of the compoſition of the Bile, they affirmed of the whole what, properly, belongs only to a part.

THE READER beholds, with pleaſure probably, the end of this tedious inveſtigation. But, although the harbour ſeems ſo near, and his impatience invites us into it,

Crebreſcunt optatæ Auræ portuſque pateſcit
Jam propior———

we cannot ſo ſoon ſtop our courſe. The Experiments ſuggeſt opinions, which, by their novelty, captivate the mind, and hurry it into theory. In ſpite of ourſelves we are carried into that ſea which has ſo often proved fatal to obſervers; and whoſe rocks, though frequently pointed out, are ſo difficult to be avoided. We ſhall give the reflections, as they naturally ariſe from the ſubject we have been examining, without ſearching after any other order.

AND this is the firſt which preſents itſelf. Of all the animal fluids, the Milk and the Bile ſeem to be the moſt analogous to one another, and to the common maſs of blood. The baſis of theſe liquors is a coagulable matter, which, though it gets ſome variety from the progreſs it has made in the ſeptic animal proceſs, and from its ſtate of union with other ſubſtances, poſſeſſes the ſame general characteriſtic properties. From the milk we obtain a matter analogous to the ſugar of vegetables; and that ſomewhat of the ſame kind is contained in the Bile ſeems evident from its ſweet taſte, extracted by ſpirit of wine, and by water; as well as from the fermentative proceſs which precedes its putrefaction. It is believed, with appearance of reaſon, that the ſame ſubſtance reſides in all nutritive matters, whether animal or vegetable *; and conſequently in the blood. We may ſuppoſe that it is evolved, and rendered more evident, by the animal proceſs for the ſecretion of the milk, and of the Bile, in ſome ſuch manner as it is

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* Dict. de Chymie, *Sucre.*

evolved, in the farinaceous ſeeds, by the vegetable proceſs attending their germination. I had no opportunity of examining the ſaline contents of the Human Bile; but Monſ. Cadet's analyſis of the Bile of the ox furniſhed him with ſome common ſalt, ſome fixed alkali, and ſome of that little known matter which has been named the eſſential ſalt of milk, from its being firſt diſcovered in this liquor. And we are aſſured, by Monſ. Beaumé, that theſe are the very ſalts which he obtained from the milk of that ſort of animals *. I do not know whether the ſaline contents of the blood have been ſo particularly enquired after; but it ſeems probable that we ſhall find theſe fluids as ſimilar in their ſerous, as in their coagulable part.

And here the connection ſeems to be at an end; for the colouring and bitter part of the Bile differs much from the colouring matter of the blood; and this is ſtill more different from the oil of the milk. Yet the greateſt chemiſts of our age, as Gaubius, and the author of the *Dict. de Chymie* are perſuaded, that the colouring matter of the blood is of a nature analogous to the oil of the milk, or of the chyle; and that its differences are to be explained from the changes, which our fluids undergo in the courſe of the circulation. But ſurely, if the powers of circulation can convert the oil into the colouring matter of the blood, as the ſame powers continue to operate, they may change this ſubſtance into the colouring matter of the Bile; for the relation between theſe ſeems to be ſtill more intimate.

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* Dict. de Chymie, *Lait*.

And what are the powers of circulation to which we principally attribute the abovementioned changes? They do not ſeem to belong to the mechanical claſs; for theſe are incapable of changing the properties of bodies. The effects of the circulation, when carried farther in the ſame fluids than Nature intended, diſcover very plainly the power which has moſt influence there. If an animal is denied all food, while his vital functions ſubſiſt in vigour, there follows ſoon a putrid diſſolution of the circulating maſs. But the ſtages of fermentation tending towards putrefaction, though we have marked but a few of them, exiſt, perhaps, in infinite variety; and thoſe we are acquainted with are remarkable for their power of producing new bodies. And if the changes of the fluids from the circulation are, in an extreme degree, the effects of an advanced ſtage of the ſeptic proceſs, is it not probable that intermediate changes are the effects of ſome intermediate ſtage in the ſame proceſs?

THIS proceſs is regulated by the circumſtances of the ſubject which is expoſed to it. Thus the coagulable lymph, out of the body, in favourable circumſtances, produces, by a ſort of fermentation, a mild *pus*. But if thoſe conditions are not preſent, which ſerve to govern the proceſs, and ſtop it at this point, it haſtens on to the ſtage which is called *putrefaction.* So we imagine that the ſame proceſs, regulated by the laws of the œconomy, produces, in the courſe of the circulation, uſeful changes in our fluids; as the converſion of the oil into the colouring matter of the blood, and of this into the colouring matter of the Bile; nor does it, except when theſe laws are broken through, proceed to the putrefactive ſtage.

THIS is the hypotheſis, which naturally was ſuggeſted by the almoſt perfect analogy of thoſe fluids. And Gaubius imagines, that the oily origin of the red globules is manifeſted in their form, which depends, he ſuppoſes, on their repulſion to the watery fluid around them. And when the red colour of the blood is diffuſed in water, this, he thinks, is owing to the intervention of the ſerum,

which

which has an effect like that of other viſcids, in rendering this oily matter miſcible with water. And hence, ſays he, it happens, that the application of a boiling heat to water, tinged by the red globules, deprives it of its colour, by coagulating, and cauſing a ſeparation of the ſerum or lymph *.

YET I found, by Experiment, that boiling water, poured upon the craſſamentum of the blood, and ſtirred with it, extracted a fine clear red colour, while it precipitated to the bottom of the glaſs a quantity of coagulated lymph, which had ſtill ſome tinge. But it appeared, that all the lymph was not precipitated, and that ſome of it remained united with the colouring principle in the tranſparent watery ſolution; for, upon adding to this a little nitrous acid, the red colour diſappeared, and there fell to the bottom of the glaſs ſome white grumes.

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* Patholog. § 342.

Thus it ſeemed, that the principle of colour in the blood reſembled the ſame principle of the Bile, in its ſtrict union with the coagulable matter, and in being of ſuch a nature as to fly off with the nitrous acid.

I THEN applied to the craſſamentum the ſtrong mineral acids, all of which formed with it turbid ſolutions, of a deep brown colour. The addition of water to theſe ſolutions cauſed a plentiful precipitation, and the colour ſeemed to follow the precipitated matter, and appeared in a circle at the bottom of the glaſs.

SOME of the craſſamentum being put into ſpirit of wine, ſeemed, after a couple of days, to have communicated very little to the ſpirit. And this circumſtance diſtinguiſhes it remarkably from the Bile; whoſe colouring matter we have ſeen is very readily diſſolved by ſpirit of wine.

Spiritus nitri dulcis extracted from a bit of the craſſamentum a dark tinge; but more ſlowly and imperfectly than it ſeparates the colouring matter of the Bile. Yet, a very ſmall quantity of fluid blood being poured into a phial of *ſp. nitri dulcis*, was entirely ſtripped of its colour; and there fell to the bottom ſome pure white coagulated matter. This tincture was opaque, like the ſame tincture of the yolk of the egg, not tranſparent like that of the Bile.

It ſeemed, from theſe Experiments, that the colouring matter of the blood, though probably of a nature analogous to the colouring matter of the Bile, is yet in a different ſtate; ſince they do not give the ſame phenomena in their mixture with the acids, *&c.*

The yolk of the egg, being intended for the formation of blood in the young fetus, is, probably, adapted to the feeble condition of the animal powers in the commencement of life. We ſhould expect to find it a blood half-prepared by the mother, and requiring only a ſlight change from the tender organs of the chick. Dr. Haller thinks that he has obſerved, with the microſcope, the gradual change of the yellow matter of the egg to red blood, in the veſſels of the young animal. But it ſeems to be compoſed, like the milk, of ingredients very analogous to thoſe of the common maſs. Indeed, as it is provided for the nutrition of a ſtill weaker animal, it ſeems to be ſtill more ſimilar to blood. It contains a colouring matter, which, like that of the blood, and of the Bile, flies off with the ſtrong nitrous acid. This matter is diſſolved by *ſpiritus nitri dulcis*, or by a mixture of *aq. fortis* and ſpirit of wine, and leaves a white curd, which ſeems to be a pretty pure coagulable lymph.

THUS have we a ſcale of animal fluids, of which all are ſimilar, yet all different; the milk, the yolk of the egg, the blood, and the Bile. The two former may be conſidered as preparations for the other two, to which they gradually approach; the yolk being the moſt analogous. It is their common character to contain a coagulable matter, united with another, that has for its chief ingredient the phlogiſton. In the milk this principle is ſo fettered by its union with other matters, as to get very nearly the form of the vegetable expreſſed oils. It ſeems to be gradually evolved by the animal proceſs, and at length, in the Bile, gives evident indications of its being preſent in a more ſimple and active ſtate. There may be in the animal body, for aught we know, an apparatus for ſeparating this matter in a pure and uncompounded form. Perhaps the brain, and its productions, is the organ intended for this function; and the phenomena of ſenſation and motion would almoſt tempt one to imagine it [*], if it were allowable to indulge conjectures in medicine, that are incapable of demonſtration.

If one were to take the two extremes of this ſcale, and compare the colouring matter of the Bile with the butter of the milk, he would ſay that their difference reſembled that between the bland, and the eſſential oils of vegetables. For, while the former is readily diſſolved by ſpirit of wine, the latter ſeems to be little affected by it; and while the milk is perfectly mild, and free from all ſtimulus, the Bile, though it is ſaid not to be bitter in every animal, is in all poſſeſſed of conſiderable acrimony and power of irritation. The colouring matter of the Bile diſcovers alſo a much ſtronger attraction to the mineral acids, and gives indubitable marks of a more evolved phlogiſton. If he were to ſuppoſe that this change is wrought by the animal ſeptic proceſs in the courſe of the circulation, he would in ſome meaſure be juſtified by our obſerving, that an analogous change is produced in the bland vegetable oils, by a ſpontaneous fermentation. For this, as well as the application of heat in diſtillation, approaches them nearer to the character of the eſſential oils. But it muſt be remembered, in conſidering this, and every animal operation, that

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[*] Vid. Theſis de Calore, Edinburg. 1770.

"'Tis but a *part* we ſee, and not the *whole.*"
Pope.

We know that there is a fermentative proceſs continually going on in our fluids, which tends to putrefaction; but we know alſo that it is regulated by the animal powers, in a manner which we do not underſtand, and ſhall never be able to imitate.

If then, according to the idea that has juſt now been expreſſed, we range theſe fluids in the order in which they have ſuſtained the proceſs of animalization, the milk and the Bile will be directly oppoſed to each other. In the former, this proceſs ſeems to have advanced farther than in the common circulating maſs; but not ſo far in the latter; and this agreeably to the purpoſe of Nature in preparing theſe liquors. The milk, being intended for nutriment merely, ſhould partake of the vegetable nature; ſince, without reaſoning on the affair, we find, by Experience, that a mixture of vegetable matter in our aliment is abſolutely neceſſary. But the Bile is to aid that proceſs by which vegetable is converted into animal matter; and therefore, we might ſuppoſe, could ſcarcely be too much animalized.

ONE is the more inclined towards this hypotheſis, by obſerving Nature's care to ſelect, for the ſecretion of the Bile, that blood in which the ſeptic animal proceſs may reaſonably be ſuppoſed the fartheſt advanced. She does not employ here, as in the other ſecretions, arterial, but venous blood; returning too from parts where fermentations, the neareſt to putrid, are continually going on; effuſed, and ſtagnating, perhaps, in the ſpleen; and ſpread out afterwards through the ſluggiſh ſyſtem of the *vena portarum.*

BUT, if the hypotheſis is well founded, we muſt obſerve, that whatever accelerates the ſeptic animal proceſs, has a tendency to increaſe the Biliary Secretion; ſince it favours that change of the blood which fits it for becoming Bile. And is it not in this light that we are to view the large ſecretion of Bile, which ſeems to be always the conſequence of a continuance of hot weather; and which ſhows itſelf, more remarkably, in the intermittent, and remittent fevers of the warm climates, ariſing from putrid miaſmata? For, that this ſymptom is not ſo much the effect of the intermittent paroxyſm, as of a certain ſtate of the fluids in the hot ſeaſon, appears from an obſervation of Mr. Cleghorn's; that when the intermittents of the Summer continued until the cold weather ſet in, they loſt their malignity and contagion, and were no longer attended by the exceſſive redundancy of Bile. And the icteric colour, which characteriſes the ſame kind of fevers, when they ſeem to have moſt of the putrid nature, is it not to be explained in the ſame manner? Some have doubted whether this appearance had any connection with the redundancy and abſorption of Bile; but it ſeems a probable opinion, from conſidering the relation of this fever to thoſe which have been called bilious; and the only obſervation, which we find directly in point, appears to confirm it. It is remarked by Dr. Lind, that the ſerum of the blood in a fever diſtinguiſhed by this ſymptom, and named on that account a *yellow fever*, had a bitter taſte.

THE abundance, as well as acrimony of the Bile, which have been obſerved in animals that were ſtarved to death, do they not correſpond exactly with this notion? Morgagni imagines, that the diſtenſion of the gall-bladder, which occurred in theſe caſes, depended on the emptineſs of the ſtomach preventing the ordinary compreſſion of that reſervoir *. But Dr. Haller found the ſtomach, as well as gall-bladder, full of Bile, in an animal that was ſtarved to death †. And another obſerver has remarked a vomiting of Bile, and jaundice, among the conſequences of a privation of food; and, we ſuppoſe, of that increaſed tendency to putrefaction which preſently follows ‡.

BUT there are other conſiderations, which ſupport the opinion of a connection between the oil, the colouring mat-

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* Ep. Anat. Med. XXVIII. § 6.

† Phyſiolog. L. XIX. ſ. ii. 11.

‡ Fanton. Diſſ. Anatom. p. 39.

ter of the blood, and that of the Bile. In the early fetus, both the blood and the Bile are without colour, and no fat is to be found in the cellular membrane. Afterwards the red globules appear; the oil is depoſited along the courſe of the arteries; the Bile acquires colour, and at length acrimony. The life of the fetus is little more than vegetable, and the animal ſeptic proceſs is then extremely weak. It would ſeem, that the firſt tinge of the Bile was derived from the red globules paſſing the Secretion, without much previous change *. Dr. Haller thinks it perfectly evident, that the red globules are formed, in the chick, from the matter of the yolk; for, the firſt appearance of colour in the blood, as it flows through the umbilical veſſels, is yellow; then a mixture of yellow and red; and ſo on to the fine florid colour of a thoroughly compleated blood. But when

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* Elem. Phyſiol. L. XXIII. ſ. iii. 1. in fetu conſtanter dulcis eſt (Bilis) mucoſa, rubra, inſipida.

we obſerve, that the firſt appearance of colour in the Bile is red, does it not become equally, probable that the red globules are the ſource of the colouring matter of the Bile, which the feeble powers of life are yet unable perfectly to form ?

And, even in the adult, when the vital powers languiſh ; when the red globules are formed with leſs facility, and water, inſtead of oil, is depoſited in the cellular membrane, as in cachexy and dropſy ; the Bile is found without its uſual colour and acrimony. Among the many caſes of this kind, the Reader muſt allow me to mention one from Gliſſon, together with the reflections which it ſuggeſted. He will ſee, that this accurate obſerver, and ſubtle theoriſt, had formed nearly the ſame notion of the Bile, that I, before I had conſulted him, was led to by my Experiments. *Erat nempè apud nos mulier chachectica, in cujus veſiculâ felleâ deprehendimus*

prehendimus humorem ſeroſum, pallidumque, minimè amaraſcentem, ſed inſipidum potius, dulcique proximum. Credibile ſanè eſt, in eâ calorem vitalem pauperiorem fuiſſe quam ut aduſtionem effecerit, adeoque excrementum illud ſine amaritudine expurgatum eſſe. Utcunque indicio eſt ſerum *neceſſariò ad humoris fellei ſtructuram concurrere.* It would be eaſy to multiply facts of this kind. Let me add another, taken from Rivalerius by Lieutaud, *Inter exenterationem cadaveris viri* chachectici, *et* Leucophlegmatiâ *diuturnâ extincti, in conſpectum veniebat veſicula fellea, humorem albicantem, et merè lacteum continens—inculpatis cæteris viſceribus* [*]. In the caſe of a dropſy following an intermittent fever, from Storck, *Cyſtis fellea continebat humorem albumini ovorum plane ſimillimum* [†].

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[*] L. 1. Obſ. 850.

[†] L. 1. Obſ. 618. Vid. etiam, Obſ. 963, 983. et Morgagn. Ep. XXXVIII. 19, &c.

Thus it appears, that the Bile is ſometimes without any colouring matter, a mere ſerum; and that theſe are the caſes in which the red globules are defective, and the proceſs for making them conſiderably impaired. And does not this confirm our idea of the origin of the colouring matter of the Bile; that it is produced from the red globules, by the abovementioned proceſs a little farther extended?

Perhaps another obſervation may ſet this in a ſtronger light. Though proper aliment be taken in, the powers of circulation are not capable of furniſhing ſoon a great quantity of red globules; and they are rendered ſtill leſs capable by being weakened. After large, and repeated evacuations of red blood, the florid colour diſappears in the vital ſtream, and frequently cannot again be reſtored.

But there is another caſe of exhauſtion, where the blood is not recruited by aliment; and, the vital functions going on, it is diſſipated by a ſpontaneous degeneracy. We find it remarked, in the diſſections of ſome people who periſhed by faſting, that their veſſels were quite empty *.

LET us now conſider the influence which theſe different caſes will have on the biliary ſecretion. If the Bile is as analogous to the Blood as the Experiments perſuade us, and the colouring matter of the one fluid is derived from that of the other, the loſs of ſuch a quantity of red globules as the ſyſtem is unable to reſtore, muſt produce a defect of colour in the Bile. By examining the accounts of diſſections, we ſhall find whether this concluſion from theory correſponds with the fact. Morgagni, in his thirty-ſixth epiſtle, and eleventh ar-

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* Morgagni, Ep. XXVIII. 4. "Venas, et arterias mirabiliter inanitas."

ticle *, preſents us with a hiſtory exactly to the purpoſe. A young man died, after repeated evacuations of blood by vomiting; *Cadavere diſſecto, mirum fuit quam modica in vaſis omnibus portio ſanguinis ſupereſſet. Itaque ventris viſcera inſueto pallore, et quaſi candore ad ſe oculos alliciebant.* He adds afterwards, ſpeaking of the gall-bladder, *Bilem continebat paucam, coloris maxime diluti, cui ſimilis in ventriculi fundo non deerat.*

MORGAGNI ſeems to doubt, whether this remarkable appearancedid not depend upon the acrid particles of the Bile being retained in the circulation. *Attamen, ipſa Bilis paucitas, ipſeque adeo dilutus color, an acriores particulas in ſanguine retineri ſignificarent, exiſtimare tu poteris.* It is unneceſſary to allege the improbability of this ſuppoſition, which is founded on an opinion now generally rejected, that the matter of the Biliary Secretion is preſent, under its proper form, in the circulating maſs. But the phenomenon is perfectly agreeable to our theory, and therefore ſerves to confirm it.

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* De cauſis et ſedibus morborum.

THE other caſe of exhauſtion, from a mere privation of food, muſt affect this Secretion in a very different manner. For here the red globules are in their due proportion, and can only eſcape by thoſe ways which Nature provided, when ſhe determined that their degeneracy ſhould make room for their renovation. But a conſequence of this ſort of degeneracy is the formation of the colouring matter of the Bile. While the blood diſappears, therefore, in the veſſels of ſtarving animals, from the exerciſe of the vital functions, we ſhould obſerve a plentiful and an acrid Biliary Secretion, with its full proportion of colouring matter. But this is really the fact; and it differs from the former, in the manner we ſhould expect from the theory.

It appears, therefore, that the proceſs for the evolution of oil, and the production of red globules, in certain circumſtances of the conſtitution, is too weak, and imperfect; and that in different, and ſeemingly oppoſite circumſtances, their converſion into the colouring matter of the Bile is too much precipitated. Theſe may be called the Phlegmatic, and the Bilious conſtitutions; and, in both, the oil and the red globules ſeem to be defective; ſince in the one they are not formed, and in the other they are too haſtily uſed, and abſtracted. Their exceſs is ſeen only in diſeaſe; but ſmaller gradations are conſiſtent with a ſtate of health; and may become general, from ſome cauſe to which men are univerſally expoſed, as the influence of climate.

THERE is yet another conſtitution, in which the evolution of oil, and the production of red globules, ſeem to proceed more rapidly than their uſe and degeneracy. We ſee many people who, with a moderate conſumption of food, are liable to a conſtant plethora; and muſt be relieved by Nature, or Art, procuring ſucceſſive hæmorrhages. A temporary plethora ſeems to be natural to every animal, ſoon after feeding; eſpecially if there are long intervals between the meals. For, during the interval, the red blood is continually proceeding in that degeneracy, which terminates in its ſeparation from the circulating maſs; and this loſs muſt be repaired by the production of new blood, as ſoon as the nutritious fluid is furniſhed to the veſſels. Dr. Haller aſſures us, that he has obſerved the pale liquor, in the veſſels of a languid frog, acquire from one good meal a florid colour, and become full of globules.

THIS leads to the conſideration of a fact, which ſeems to agree with ſome of our preceding reflections. The ingenious Mr. Hewſon has collected a number of obſervations, relative to the appearance of oily globules floating on the blood, and giving to its ſerum a near reſemblance with milk. He ſhows us that this is not the mere effect of an admixture of chyle; ſince it appears in the animals whoſe chyle is tranſparent; yet, only when their blood is inſpected within a ſhort time after feeding.

Now I cannot help fancying, as we know the proceſs for making red globules to proceed briſkly ſoon after the introduction of aliment, that this appearance ſhould be conſidered as the beginning of the proceſs, and the firſt ſtep towards the production of red globules. After a certain period, the oily particles are no longer to be ſeen; becauſe, moſt probably, they are uſed by this time;

being in part converted, by the powers of circulation, into the colouring matter of the blood.

And we obſerve in all the caſes, given us by Mr. Hewſon, of this phenomenon in the human ſerum, that the proceſs for making red blood was in exceſs; ſince the perſons had ſymptoms of plethora, though they took but little food, and were all relieved by large and repeated hæmorrhages. It would ſeem, that the evolution of oil, and its converſion to red globules, (which are found to have place naturally during a certain time after the admiſſion of aliment) from ſome peculiarity in theſe people, were going on conſtantly, and furniſhing ſuch a quantity of blood, as made its frequent evacuation neceſſary to the œconomy.

The excellent obſerver, to whoſe work I refer, ſuppoſes that this appearance depended on the oil of the adipoſe membrane being conveyed into the blood-veſſels, for the purpoſe of nutrition. But if the oil is laid up in this membrane, to anſwer the exigencies of Nature, why is it improvidently abſorbed when there is no occaſion for it; while a quantity of freſh aliment is mixing itſelf with the blood? And though animal fat, when it has undergone the powers of digeſtion, ſupplies the ſyſtem with a very nutritious fluid, does it follow that fat itſelf is the matter employed in nutrition? or is there ſo exact a reſemblance between the tranſparent chyle of birds, and globules of oil, that Nature uſes them as vicarious inſtruments *.

We may now take ſome notice of the coagulable part of theſe ſimilar fluids. The lymph of the blood appears under two different forms; as merely diffuſed in the watery liquor, and ſeparating from it

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* Experimental Enquiries, p. 149.

when left at reſt, the ſooner if it be at the ſame time expoſed to the air; or as intimately blended with, and diſſolved by it in the form of ſerum. The conſiſtence of the blood ſeems to depend chiefly on the former; in preparing which, one intention of Nature was probably to confine a certain quantity of the fluids within the vaſcular ſyſtem. We ſhould not expect, therefore, to find this ſort of coagulable matter in the ſecretions, where there is no occaſion for it. But the ſerum ſeems to be continually produced during the exerciſe of the vital functions, and to be continually paſſing off by the ſecretories. And it is probably formed from the diffuſed coagulable matter, by the powers of circulation; for, while theſe powers produce the ſerous diſcharges, they leſſen continually the quantity of that matter. And hence, where freſh aliment is not taken in, the blood loſes its natural conſiſtence, is no longer confined to the vaſcular ſyſtem, but is effuſed from the veſſels of the noſe, of the inteſtines, *&c.*[*] And it would ſeem, that this change of the coagulable matter of the blood was the effect of the ſeptic animal proceſs, which takes place in the circulation; for it appears to be accelerated by hot weather, by the cauſe of putrid fevers, by half-putrid aliment producing ſcurvy.

But, as we ſuppoſe that the differences of the Bile, from the blood, depend chiefly on the effect of this proceſs, in changing continually the qualities of the latter fluid; we ſhould not expect to meet with any of that diffuſed coagulable matter, which ſeparates ſpontaneouſly, and concretes on expoſure to air, in the Biliary Secretion. The coagulable part is here intimately blended with the watery; and both with the colouring matter. We generally obſerve in the blood, when from any circumſtance it is long in concreting, that a part of the coagulable matter ſeparates, and, ariſing to the ſurface, produces the buff-coat; and, even in the body, ſuch ſeparations frequently happen, and give riſe to what are called *polypi*. But we do not diſcover in the Bile, though it never concretes ſpontaneouſly out of the body, any ſuch ſeparation of the coagulable from the colouring matter. It is ſaid alſo that, by ſimple agitation in water, a part of the coagulable lymph may be obtained quite pure from red globules. But we find it difficult to obtain any portion of the lymph of the Bile, pure from all admixture of the colouring matter; and it can only be done by applying to the Bile the peculiar ſolvent of this matter. As the Bile advances towards putrefaction, the union of the coagulable and colouring matters ſeems to grow ſtill more intimate; ſo that ſpirit of wine extracts, together with the latter, a quantity of the former, ſufficient to render it extremely viſcid. And does not this look like the continued progreſs of an effect, correſponding with the progreſs of its cauſe? We ſuppoſe then, that the union of theſe parts of the analogous liquors is gradually rendered more perfect, by the continuance of the animal ſeptic proceſs. And if we return to the ſcale of fluids, which was formerly propoſed, we ſhall find that in the milk, at the one extreme, this union is the leaſt, while, in the Bile, at the other, it is the moſt complete.

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[*] Haller Phyſiolog. L. XIX. ſ. ii. 11.

THUS having ſeen that the Bile was nearly related to ſome other animal fluids, and particularly to the common ſource of all, the maſs of blood; we have ſince endeavoured to make it appear probable, that its differences are the effects of a power, which is continually operating in the animal body, and changing the qualities of its liquors with their ſtate of mixture. And this notion is the more ſatisfactory, as it ſeems to correſpond with that peculiar mechaniſm, which Nature has employed for the Secretion of the Bile; and, at the ſame time, to explain one of the moſt remarkable facts in the hiſtory of this Secretion. I mean, at preſent, that great redundancy of Bile, which is commonly produced by a continuance of hot weather; and is particularly connected with the intermittent and remittent fevers, and the dyſentery of warm climates. This connection is ſo conſtant, that it has been ſuppoſed neceſſary; and, from the circumſtance alone of the altered Biliary Secretion have been derived all the other phenomena of theſe diſeaſes. But we frequently ſee vaſt quantities of Bile diſcharged into the inteſtines, without producing either fever, or dyſentery. And this is eſpecially the caſe in the *cholera morbus*; which ſhews itſelf ſometimes in this climate about the autumn, and in hotter countries before this period, during the courſe of the Summer; and appears to be the true and genuine effect of heat. The diſeaſe conſiſts in a more abundant, and probably a more acrid Secretion of the Bile; and it is to be explained from the known effect of a continuance of hot weather, in favouring the ſpontaneous degeneracy of our fluids, and in accelerating that ſeptic animal proceſs, by which we imagine the blood is converted into Bile.

THE intermittent and remittent fevers, and the dyſentery of the warm climates, are nearly related to each other, and have the altered Biliary Secretion for their common attendant. That they do not, however, depend upon it as a cauſe, appears from what has been already mentioned; and obſervations made in the countries, which are eſpecially infeſted by theſe annually returning plagues, prove that they are more intimately connected with another circumſtance. They rage violently in certain places, while in others very little diſtant they are not known. And it appears, from the fulleſt induction of facts, that this difference depends merely on the ſituation of the place with reſpect to marſhes, and ſuch like ſources of unwholſome exhalation. The nature of this exhalation is more obſcure. It does not ſeem to be mere water; for the banks of rivers are healthy ſituations, unleſs the water, eſcaping its bounds, has formed a contiguous marſh. And, on draining the foſſæ around a fortified town, ſuch a quantity of malignant intermittents have appeared, that it has been found neceſſary to open the ſluices, and let in the water again. Freſh water deſcending in ſhowers upon the marſhes, and rivers overflowing them, have ſometimes ſtopped the fury of the endemic. And it has been obſerved that the fevers did not rage, until the water was ſo far evaporated, that the mud began to appear.

Nor ſhould we expect the noxious effects of marſhes from a mere watery vapour. The inhabitants of hot climates find this as convenient to health, as to luxury; and have been ingenious in contriving the means of ſurrounding themſelves conſtantly with ſuch an atmoſphere. The coolneſs produced during the evaporation affects moſt agreeably the ſenſe of the epicure, and is not forgotten by the poet in his voluptuous deſcriptions.

But the vapour of marſhes diſcovers, in certain caſes, a power equal to that of the ſtrongeſt contagion *. The effluvia from priſoners, ſhut up in a cloſe place, and allowed no change of clothes; whoſe perſpirable matter, retained about their bodies, degenerates into a poiſon; do not more certainly and immediately produce a fever, and that of the worſt kind. It is probable that both theſe miaſmata are derived from a ſimilar ſource. The marſhes

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* Lanciſi. Lind.

contain ſubjects extremely diſpoſed to putrefaction; as a mixture of dead animals and vegetables. One may ſee in Lanciſi a curious experiment, to ſhew the quantity of animal matter in theſe nurſeries of diſeaſe *. They are perfectly innocent during the winter. Heat is required for the production of the active vapour, whoſe malignity ſtill increaſes with the heat. It is alſo neceſſary, as has been already obſerved, that the greater part of the water ſhould be evaporated, and the acceſs of the air permitted. Thus are the circumſtances, which are neceſſary to putrefaction, eſſential to the production of this vapour; and the matter which yields it is extremely putreſcent.

Woods have been accuſed of producing, in warm climates, the ſame kind of pernicious effects as the marſhes. And it appears, from an experiment of Dr. Hales, that the perſpirable matter of vegetables

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* De nox. Palud. Effluv. lib. i. pars i. cap. xvi. ſ. xi.

getables is not mere water, but a putreſcent liquor. The action of the vapour ſeems to correſpond with this idea of its origin. It is ſaid to accelerate the putrefaction of animal ſubſtances; cauſe a ſolution of old cicatrices; and convert the ſmalleſt ſore into a putrid ſpreading ulcer. They obſerved in the hoſpital of Jamaica, while it was ſituated near a marſh, that a diſeaſe, which had the form of a ſimple intermittent when the patient came in, acquired preſently a malignant nature; that the yellow fever frequently appeared there, with blood diſſolved, and eſcaping from every paſſage; that convaleſcents from the dyſentery, upon taking the ſmalleſt quantity of animal food, even a little broth, relapſed again into the diſeaſe *.

We may add, to the other facts, a remark of the ſagacious Dr. Lind; that the cuſtom of hanging camphor about

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* Lind.

the neck is by no means a deſpicable precaution againſt the effects of this vapour. Nor is there any neceſſity for believing, with the vulgar, that it acts as a charm; or in a manner which we cannot comprehend. Camphor, as appears from Sir John Pringle's experiments, is powerfully antiſeptic; it is at the ſame time volatile in the common heat of the air; and we can ſcarcely conceive a more rational method of obviating the action of a putrid vapour, than the ſurrounding the body with an antiſeptic atmoſphere. The various fumigations, which have been ſo much extolled for their power of deſtroying, or of preventing the effect of this vapour, operate moſt probably in a ſimilar manner. They all agree in the property of furniſhing, during their conſumption, a volatile antiſeptic matter. A burning body, whatever may be its peculiar nature, muſt occaſion the production of a large quantity of *mephytic* air; which has a moſt remarkable effect in correcting putridity.

tridity. And it is worth obſerving, that Gun-powder, the ſubſtance which Dr. Lind recommends, as moſt effectual in the way of fumigation *, is eſpecially replete with

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* Eſſay on preſerving the Health of Seamen, p. 116.——Yet I muſt not be ſuppoſed to derive all the advantage of theſe fumigations from mephytic air; ſince the antiſeptic principles, which they furniſh, may be as various as the volatile ingredients in their compoſition. The remark is chiefly by way of caution to thoſe gentlemen, who confound, under a common name, the airs injurious to animal conſtitutions. Even Dr. Lind, whoſe induſtry and ingenuity can never be ſufficiently commended, ſeems to have fallen into this error. For, after obſerving, that the air in the hold of a ſhip was ſo *poiſonous*, that the people who deſcended into it were immediately ſuffocated, he adds, as ſomething extraordinary, "Yet "this ſhip was remarkably healthy *." The air, from its effect, muſt have been *mephytic*; and, though fatal at its ſource, its diffuſion through the ſhip ſhould rather oppoſe the diſorders which are moſt deſtructive to ſeamen; as they are generally of the putrid kind.

* Lind, l. c. p. 113.

with this air, and owes to it that deſtructive quality for which it is chiefly valued.

To enquire, more particularly, into the nature of the miaſma, we ſhould be in a condition to ſubject it to a chemical inveſtigation. How various are the cauſes of diſeaſe, that act in the way of miaſma and contagion? We perceive, evidently, a difference in their operation; but we ſearch in vain for that ſpecific difference in their nature, on which it depends.

THOSE miaſmata, which occaſion fever, ſeem to be all the offspring of the ſeptic proceſs, and to have more or leſs tendency to accelerate that proceſs in the animal œconomy. We are acquainted with two kinds of vapour, which are ſeparated from

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My friend Dr. Lettſom ſeems to promote this confuſion, when he talks of mephytic air being produced, "in a peculiar manner, by the putrefactive fermentation;" and of its occaſioning putrid diſeaſes. Naturaliſt's Companion, p. 41.

bodies during putrefaction; and are ſufficiently diſtinguiſhed from each other, by their different, and even oppoſite qualities. The one extinguiſhes flame, while the other is inflammable; and as the former is remarkable for its power of oppoſing putrefaction, ſo the latter, I imagine, rather tends to promote that proceſs *. This inflammable air is the peculiar offspring of putrefaction; while the other, which has been named *mephytic*, is ſeparated in much greater quantity during the previous ſtages of fermentation. The miaſma which produces fever, appears, from its origin and its effects, to have a much greater analogy with the former, than with the latter kind of vapour.

THIS miaſma, like the other vapours of the ſame ſpecies, like that of gangrene, which ſeems the moſt powerful of them all, operates on the nervous ſyſtem as a ſedative, and tends to deſtroy the force of the vital power. When it is in a concentrated ſtate, it produces immediately a vomiting, and an exceſſive proſtration of ſtrength *. Whatever, therefore, diminiſhes the tone of the fibres, and weakens the nervous power, diſpoſes to its action; intenſe ſtudy, grief, exceſſive venery, that relaxation even which accompanies ſleep.

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* Or why is the putrefaction accelerated in a body, by preventing the free acceſs of air?

It is, I preſume, in conſequence of this operation on the nervous ſyſtem that it produces fever; as an effect of the reaction of the vital power, or of the efforts of Nature to reſtore its diminiſhed vigour. And therefore, where the vapour is exceedingly concentrated, it may, like the contagion of the plague in certain inſtances, deſtroy life without producing a fever †. As it appears to be a ſeptic, this

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* Lind.

† Is this the caſe in that peſtiferous air which is known by the name of Samiel; concerning

this action on the nervous ſyſtem will be accompanied with ſuch a change in the fluids, as may be expected from the introduction of a putrid ferment; and in this way it muſt influeuce the character of the fever which ariſes.

BUT theſe effects of the vapour, though generally complicated, are not always in the ſame proportion. The action of any power on the animal machine muſt be modified by its different ſtates. *Non bruta homo machina eſt, quæ injurias a rebus noxiis ſibi illatas iners excipiat, ac patiatur*[*]. We know very well, that a gangrene happens in one perſon, from an injury which only excites inflammation in another; that a gangrene, after it has made ſome progreſs, is frequently checked by the powers of the conſtitution, without any aſſiſtance from medicine. But when

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ing which Dr. Haller gives us the following obſervation from Chardin, *Continuo putreſcunt quos ventus Samiel percuſſit, ut membra tracta manum ſequantur?*

[*] Gaub. Patholog. ſ. 99.

we attempt to aid Nature, in her oppoſition to this moſt powerful of all ſeptics, what do we do? We endeavour, by the uſe of the bark, to ſtrengthen the nervous ſyſtem, and to communicate a firmer tone to every muſcular fibre. It ſeems that the conſtitution, in this ſtate, can reſiſt the action of ſeptic powers; and the nearer it approaches to this ſtate, the leſs will it ſuffer, probably, from the miaſma operating as a putrid ferment. It may ſtill produce fever; but the vigorous reaction of the ſyſtem will give this fever, in its beginning, the inflammatory, rather than the putrid character.

WE are not ſurprized, therefore, to ſee in Lanciſi * a deſcription of two diſeaſes, raging at the ſame time, and depending on the ſame cauſe, the marſh effluvia, yet of a very different form. The one, an intermittent fever, afflicted thoſe eſpecially, who had previouſly a weakened and bad habit of body, and were neareſt

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* L. ii. Ep. i. cap. v.

to the ſource of the exhalation. The other was a continued fever, and happened only to the robuſt and well-coloured, who were farther removed from the marſh. The intermittent was preceded by an icteric colour, and uſhered in by exceſſive bilious vomitings. On diſſection, the liver and the inteſtines appeared to have been the chief ſeat of the diſeaſe, *Grande morboſæ devaſtationis theatrum hepar et inteſtina*; and it was remarked particularly, *bilis cyſtica atri coloris paſſim occurrit.* In the continued fever there were not ſymptoms of an equal redundancy of Bile; nor did diſſection ſhow the ſame morbid appearances in the abdominal viſcera.

Now, when I reflect, that the liver ſeems to be deſtined to the ſeparation of degenerating blood, and the marſh miaſma to operate as a putrid ferment, I cannot help fancying that we perceive a reaſon why the ſecretion of this organ is peculiarly affected, in the intermittent and remittent fevers of the hot climates. And we obſerve, I think, in Lanciſi's hiſtory, that where the miaſma, from being more concentrated, and meeting with a body leſs capable of reſiſting its ſeptic power, exerted this power in the higheſt degree, there the change on the Biliary Secretion was the moſt remarkable. As the urine or perſpiration, the chief vehicles of the ſaline and watery parts of our blood, are generally increaſed by increaſing the quantity of theſe matters in the circulating fluids; ſo the Biliary Secretion, being intended by Nature for the diſcharge of degenerating lymph and red globules, is augmented with their degeneracy.

And thus it would ſeem, that the change on this ſecretion, far from being the cauſe of the bilious intermittent and remittent fevers, is a means which Nature employs in theſe diſorders for her relief. And is not this confirmed by an obſervation of Sir John Pringle, that a *cholera morbus*, or an exceſſive diſcharge of Bile both upwards and downwards, was the only critical evacuation which occurred in this fever; and ſometimes gave a quick and happy termination to the diſeaſe *? And does it not agree with another remark of this excellent obſerver, that the vomits, of greateſt uſe in the fever, were thoſe which produced the moſt copious evacuation of Bile †? I ſhould be inclined to think, that

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* Diſeaſes of the Army, p. 186.

† Ibid. p. 208. "I obſerved that vomits were "ſtill more efficacious in the marſhes, than in "the camp; inſomuch, that when a large quantity "of Bile was evacuated by an emetic, the fever "would often be removed at once." We find, in this remark, a confirmation of the opinion ſuggeſted by Lanciſi's Hiſtory; that where the active miaſma is more concentrated, and conſequently a ſtronger ſeptic, there the diſcharge of Bile is more neceſſary to the conſtitution; and greater advantage reſults from augmenting it by the aſſiſtance of art.

Sarconi,

that the general method of cure in theſe fevers, except where ſymptoms of topical affection required attention, ſhould conſiſt in promoting, by the ſafeſt and moſt expeditious means, the biliary diſcharge; and in correcting, by tonics and antiſeptics, that ſtate of the conſtitution which makes it neceſſary.

THOUGH the colouring and bitter part of the Bile has appeared to be the production of the animal ſeptic proceſs; yet we are perſuaded by the Experiments that it is capable of oppoſing that proceſs. Nor will this ſeem extraordinary, when we conſider that vinegar, ſpirit of wine, and volatile alkali, the offsprings

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Sarconi, in his account of a fever that raged at Naples, has repeated the obſervation of Sir John Pringle, with reſpect to the advantage of a ſpontaneous cholera. "*Molti eranſi felicemente ſoſtrattia i* "*ſecondi effetti del male, col' ſuffragio d'una celere, et* "*ſpontanea colera.*" Hiſt. rag. de Mali oſſervat. in Nap. § 794.

of three determined ſtages of fermentation, are endued each with the power of reſiſting the proceſs by which it was generated. We may ſuppoſe that Nature meant, by this ſubſtance, a kind of guard to the putreſcent coagulable matter, through thoſe tortuous paſſages in which the Bile, before its excretion, is often ſubject to conſiderable delay. In the inteſtines too it will cauſe that irritation, which ſeems to be neceſſary to their perfect action. There are few nations, I believe, however near to the fancied ſtate of Nature, and ignorant of the arts of luxury, that do not join ſome ſtimulating ſubſtance with their ordinary food. But I ſuſpect that ſomething more was intended by this ſecretion; and it is this farther purpoſe of Nature, which ſhall be the next object of our enquiry.

PATHOLOGISTS are divided in their opinion, with reſpect to the manner in which the Bile gets into the circulation in jaundice; whether it meaſures back its way through the paſſages by which it was ſecreted, or takes the courſe of the lymphatics. The latter notion ſeems the moſt probable, as it is more analogous to the ordinary method of the œconomy; and on account of the reſiſtance, which the Bile muſt meet in its paſſage back, from the fluid in the ſecretory veſſels moving in an oppoſite direction. It is even aſſerted, from anatomical facts reſpecting injections, that, while the paſſage into the duct is eaſy, the return through the biliary pores is extremely difficult *.

But we obſerve, in certain caſes, that the Bile evidently gets into the road of circulation, by the abſorbent ſyſtem; as where there is no obſtacle in the excretory duct, but a great increaſe of the ſecretion.

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* Prælect. Anatom. cl. Monro.

THIS certainly happens in ſome fevers, as well as other more chronic caſes of a redundancy of Bile. I knew a gentleman, ſubject to a diſorder of the latter kind, who conſtantly became yellow after the operation of an emetic; which muſt depend, I imagine, upon the Secretion of the Bile being more increaſed than its evacuation, by the emetic ſtimulus. But it is objected to the notion of abſorption, that this fluid is continually flowing into the inteſtines, and preſenting itſelf to the mouths of the lacteals; and yet it does not, ordinarily, paſs into the ſyſtem. Is there any proviſion againſt the abſorption of Bile, which, though ſufficient for its purpoſe in the common ſtate of the Secretion, is inadequate in the caſes of a great redundancy?

WHEN I conſider the common theory of digeſtion, and compare it with the events of the Experiments, I am ready to fancy that we are in condition to throw ſome light on this queſtion. The nature of the food, its circumſtances in the ſtomach, and the phenomena it occaſions there, are ſo agreeable to the doctrine of fermentation, that it ſeems now to be generally applied to the firſt changes of our aliment. But the experiments *, which Dr. Ruſh made upon the contents of his own, and of his friend's ſtomach, tend to perſuade us, that this fermentation always proceeds to the acetous ſtage, and that there is a conſtant generation of acid from digeſtion. As ſoon as the acid liquor paſſes out by the *pylorus*, it muſt meet with the Bile in the *duodenum*, and the effect of this concurrence may be collected from Exp. IX. *& ſeq.* The Bile will be coagulated, and, after this operation, being neither fluid itſelf, nor miſcible with the fluids of the inteſtines; which, with reſpect to their ſolvent power, may be conſidered I imagine as little ſuperior to common water; it cannot be abſorbed, but muſt paſs off with the *fæces*. But, in the caſes of a great redundancy of this fluid, the proportion between it and the acid of the ſtomach will no longer be preſerved; and, conſequently, there we may ſee the abſorption of Bile, unleſs it is carried off by an increaſed inteſtinal diſcharge.

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* Theſis, upon Digeſtion, publiſhed at Edinburgh, 1769.

THE Bile, after its coagulation, imparts ſomething to water, and therefore to the fluid in the inteſtines; and this ſoluble part is probably capable of being abſorbed. And we find, from the Experiments, that the watery infuſion of the coagulated Bile is much more antiſeptic than the unaltered fluid. By this ſort of decompoſition, therefore, which takes place in the inteſtines of the animal, the antiſeptic principle of the Bile is ſomewhat evolved, and ſeparated from the putreſcent coagulable matter; and while the latter is left to the alvine excretion, the former is applied perhaps to uſeful purpoſes in the œconomy.

WHEN we view this operation, by the imperfect light which the Experiments afford, it appears to be an exchange, made by the conſtitution, of one fluid for another endued with ſtronger antiſeptic power. It will vary therefore, we may ſuppoſe, with the exigencies of the œconomy. And this gives us another view of the final cauſe of that larger Secretion of Bile, which is the conſtant effect of a long-continued heat. We conſidered it, before, as correſponding with the more rapid progreſs of the circulating fluids in their ſeptic degeneracy. But it is agreeable to the wiſdom of Nature, that ſhe ſhould, by the ſame contrivance, ſeparate from the maſs a matter which was growing pernicious, and prepare one that ſhall be uſeful. And, accordingly, ſhe has taken the greateſt pains to make the quantity of acid in the ſtomach, at this period, bear a proportion to the redundancy of Bile; that ſo the operation may be completed. She covers the earth with a quantity of acid, or aceſcent fruits, as tempting to the eye as they are delicious to the palate. She diminiſhes our appetite of hunger, while ſhe increaſes that of thirſt; and thus. not contented with alluring us by pleaſure, ſhe ſeems willing to determine our choice of food by neceſſity. At the ſame time ſhe diffuſes over us an indolence and inactivity, that while they make a more ſubſtantial aliment unneceſſary, deprive us of the inclination to ſeek it. Without the artificial diſtinctions of Society, neither bread nor meat could be obtained, except by the labour of the individual. But the fruits, in ſuch climates and ſeaſons, preſent themſelves ſpontaneouſly

> ———*Nullis hominum cogentibus ipſæ*
> *Sponte ſuâ veniunt*————.

AND what we collect from tracing the plan of Nature, is farther confirmed by experience. A moſt accurate obſerver aſſures us, that the people who kept the vineyards in Minorca, and ſubſiſted chiefly on grapes, eſcaped the diſorders of the hot ſeaſon *. One properly imbued with a late faſhionable theory, will derive all the advantage of ſuch a diet, from the quantity of fixed air with which it would furniſh the œconomy. But does this air ever enter the abſorbents, and paſs into the road of circulation, in its pure and ſimple ſtate? Or, if it did, would it not produce the moſt dreadful ſymptoms, terminating in a ſpeedy death? But has it been proved that fixed air, in compoſition, retains the quality of reſiſting putrefaction, any more than its power of extinguiſhing flame? It is a fallacious notion, that the properties of compounded bodies are known from the effects of their ingredients, in a ſimple ſtate.

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* Cleghorne Diſ. of Minorca, p. 179.

No point in phyſics ſeems to be better underſtood, ſince the ingenious and ſatisfactory Experiments of Dr. Black, than the nature of quick-lime, or its difference from the common calcareous earth, which efferveſces with acids. It has been clearly demonſtrated, that this difference depends on the fixed air; which is combined with the latter, but has been ſeparated from the former by the action of the fire. Yet it appears, from the Experiments of Sir John Pringle, that chalk promotes putrefaction, while lime-water rather oppoſes it. And this is the only difference which we can diſcover between the ſeptic calcareous matter, and the lime; that the firſt of theſe ſubſtances is fully ſaturated with fixed air, which the other has been entirely deprived of, to render it ſoluble in water. The patrons of this theory muſt reconcile it to ſuch plain and intelligible facts as the preſent, before they pretend to talk of the effects of fixed air as an ingredient in bodies, which are ſo compounded that we can form of them only general and indiſtinct notions. And, in the mean time, they muſt allow me to derive ſome ſhare of the advantage, which reſults from the uſe of acids and aceſcents in all caſes where the ſeptic animal proceſs is too much accelerated, from the effect they have upon the Bile. The ſecretion of this fluid is, in ſuch caſes, more abundant, and probably more acrid; and by its peculiar action on the inteſtines, may produce perhaps the inſtinctive craving, which people in this ſtate commonly have, for the milder and more agreeable acids. Yet in whatever quantity theſe may be taken in, we do not ſuppoſe that they can enter the abſorbents, and get into the road of circulation, in a pure and uncompounded form. But that antiſeptic, to which they give origin by their operation on the Bile, moſt certainly may; for it is a native of the œconomy, perfectly animal, and homogenous with the reſt of our fluids. It is formed in the beginning of the *duodenum*, and therefore mixes with the aliment juſt before its abſorption; being intended, without doubt, for retarding in ſome degree the effect of thoſe powers of circulation, to which it is now to be expoſed, and whoſe conſtant tendency is to induce putrefaction.

THAT progreſſive fermentation, which has place continually in our fluids, from their firſt change in the ſtomach to the time of their excretion, is regulated, we ſuppoſe, and kept from arriving at its laſt term by the colouring matter of the Bile; ſomewhat in the ſame way that the fermentation in beer is prevented from running precipitately through the ſucceſſive ſtages, by the artful addition of hops. And Nature, it ſeems, has taken care, that the proviſion of this matter ſhall be increaſed by thoſe very cauſes, which, as they accelerate the ſeptic animal proceſs, make a greater quantity of it neceſſary.

But we muſt concur in the operation, and make uſe of the acids and aceſcents, which ſhe diffuſes ſo liberally, and directs us to by the unerring voice of inſtinct. This voice, however, is frequently drowned by habit: we return conſtantly to a table prepared in the ſame manner; and inſtead of being guided by our appetite, we ſubject it to the government of faſhion. If the natives of cold climates, when they migrate into warmer, could leave behind them their modes of living, and adopt others more ſuitable to their circumſtances, they would probably eſcape much of that miſchief, which the change brings upon their conſtitutions. Yet, a ſudden tranſition from the plentiful, and invigorating diet of the north, to the weak, and ſlender ſubſiſtence of the ſouth, might occaſion ſuch a debility, as would favour the operation of the chief cauſe of diſeaſes in the hot climates. But this effect might be prevented by a gradual change; and it is no greater objection to the advantage of a diet of fruits, and other parts of vegetables, in ſuch climates, than the weakneſs, which attends the beginning of ſobriety after a debauch, is to a temperate way of life. Yet ſometimes, certainly, there occurs in theſe countries a force of miaſma, which no power of the œconomy can oppoſe, though aſſiſted by the beſt regulated life; and we may ſay in vain of our patients,

——Atqui non Maſſica Bacchi
Pocula, non illis epulæ nocuére repoſtæ.
Fructibus, et victu paſcuntur ſimplicis herbæ;
Pocula ſunt fontes liquidi, atque exercita curſu
Flumina; nec ſomnos abrumpit cura ſalubres.

Among the curious facts in the hiſtory of this Secretion, may be conſidered its relation to the paſſions. That it is remarkably affected by anger, is ſo generally known, as to be alluded to in the common expreſſions of moſt languages. And in medical obſervations, we find exceſſive diſcharges of Bile, and jaundice, related among the effects of this paſſion.

But the operation of terror, which, in the other circumſtances, reſembles ſo much that of anger, agrees with it alſo in the change of the Biliary Secretion. Theſe paſſions, though apparently very different, are believed by Haller to be nearly a-kin to each other. They certainly both relate to ſelf-preſervation, and prompt us to oppoſe, or avoid any power which threatens danger. We ſhould expect, therefore, to find the changes they produce in the body conducive to this end. And it ſeems the evident tendency of their operation, to give greater power, and a capacity of quicker and ſtronger motion. The heart beats more vehemently, and by a vigorous impulſion of the fluids, gives a more exquiſite tenſion to the whole vaſcular ſyſtem. The brain acts with more force upon every muſcular fibre; ſo that paralytic limbs have ſometimes been reſtored, by theſe paſſions, to their power of motion.

AND here, I imagine, we muſt look for the final cauſe of that larger Secretion of Bile, which generally attends them.

THE vigour of the whole ſyſtem depends upon the ſtate of the moving power in its ſeveral parts. But there is a kind of prerogative in ſome of theſe parts, which gives them a more eſpecial influence; and this is particularly remarkable of the ſtomach, and inteſtines. In an indolent, and luxurious age, when a weakneſs of theſe organs is ſo common a complaint, every one has an opportunity of obſerving, with what a general languor, and debility it is accompanied. We frequently find low-ſpirits, timidity, and deſpair itſelf, to be the effects of a feeble ſtate of action in the alimentary canal.

AN oppoſite temper of mind is connected with an oppoſite ſtate of this function; as well as with a vigorous action of the heart and arteries. And it is this temper, fit to encounter danger, which Nature endeavours to procure by the phyſical effects of anger. For the ſame reaſon that ſhe excites a more vehement contraction of the heart, ſhe pours a quantity of bitter fluid into the alimentary canal, and ſtimulates it to a ſtronger action. Thus have I attempted to anſwer the queſtion propoſed by Haller, *In irâ quid in emotâ bile boni**? Nor ſhould it be counted an objection to the doctrine, that in particular conſtitutions, where this canal is too irritable, the ſtimulus of a larger ſecretion of Bile is ſometimes productive of a diarrhœa. For Nature

> *Acts not by partial, but by gen'ral laws.*
>
> POPE.

THE mechaniſm, by which this effect of the paſſions is produced, muſt remain a ſecret, until we know more of the nature of the nervous power, and of the manner in which it influences the changes of the fluids, in digeſtion, and in ſecretion. One might ſuſpect the more violent circulation, which accompanies anger, to be the ſource of the larger ſeparation of Bile. But the ſame cauſe muſt bring a greater quantity of blood to all the other glands, as well as to the liver. Why then is the ſecretion of milk dried up moſt commonly by a violent fit of paſſion? And ſometimes, it is ſaid, this liquor, which is generally ſo mild, and nutritious, is converted by anger into a poiſon, extremely injurious, or fatal to the infant. The ſame paſſion has been known to produce a ſudden, and a fatal gangrene *. When one hears of ſuch facts as theſe, he is almoſt tempted to imagine, that the nervous power has the ſame relation to the fluids of the animal, which the electrical power has to fermenting liquors; and that certain changes in its condition, can alter preſently their ſtate of fermentation, and with it their qualities.

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* Phyſilology. L. xvii. Sect. ii. ſ. vii.

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* Hall. Phyſiolog. Loc. cit.

WHAT do we generally mean by a bilious Temperament? Is it that original conformation, which diſpoſes one perſon to be greatly moved, by cauſes that do not much affect another? This temper is certainly more prone to the paſſions, which are naturally attended with an exceſſive ſecretion of Bile.

THE ſource of ſenſibility, that fundamental part of the animal machine, is liable to very different conditions. It is influenced in a particular manner by heat, and by cold; and on this alteration which it receives from climate, ſeems to be founded, in great meaſure, the diverſity of temperament, and character, which we diſcover in different nations. The national character may certainly be altered extremely by moral cauſes; but the original ſtrong lines will always remain. When Livy ſpeaks of the inhabitants of Gaul, and of Spain, they are diſtinguiſhed by that very oppoſition of character, which has been remarked in them ever ſince; the ſame ſerioufneſs, ſolemnity, and ſteadineſs on the one hand; the ſame levity, fickleneſs, and impetuoſity on the other. There is one ſtate of this power, in which the life of the animal is raiſed only a degree above that of a vegetable. It is the effect of exceſſive cold, and happens to thoſe animals, which in the northern climates ſleep during the winter. If we may credit the accounts of them, they continue ſometimes ſix or ſeven months in a ſtate of torpor, the ſlow and feeble motion of the heart alone diſcovering ſome remains of life; and during all this time, they take in no kind of aliment, and ſeem to have no ſort of excretion. The ſeptic animal proceſs is ſo weak, that their fluids do not ſuffer the ordinary degeneracy, and conſequently they neither require to be recruited by freſh aliment, nor to have their moſt altered parts ſeparated. The men who inhabit theſe climates, are able, by certain precautions, to preſerve conſtantly the heat of their body at the ordinary ſtandard. Yet this does not prevent the cold from having a certain effect upon them, both in diminiſhing their irritability, and in retarding, in ſome degree, the ſeptic animal proceſs. It has been obſerved that their pulſe is much ſlower than that of the natives of a hot climate; ſo that, in compariſon, the latter may be ſaid to be in a conſtant fever. And it is well known that, the ſeverity of their ſky denying them vegetables, they uſe a very putreſcent diet, conſiſting chiefly of fiſh, and yet are not ſubject to ſcurvy, or any other putrid diſeaſe.

THIS conſtitution may ſhew that which is exquiſitely bilious, as it were by contraſt; for it is its oppoſite. Here the irritability is augmented beyond the proper ſtandard, the pulſe is quicker, and the progreſs of that ſeptic animal proceſs to which the Bile owes its origin is too much accelerated. As the former ariſes from the effect of great cold on the conſtitution, this is naturally produced by exceſſive heat, and the bilious temperament is the common one in warm climates.

But other cauſes, which affect the ſyſtem in a ſimilar manner, may have a tendency to induce this conſtitution. Such are, probably, a great and continued agitation of mind, either from the paſſions, buſineſs, or ſtudy; exceſſive and irregular muſcular motion; a diet too ſtimulating, and without a juſt proportion of vegetables; the abuſe of warm liquors; a too conſtant confinement to the hot and cloſe air of a chamber; the reſiding in a large and populous city.

The bilious conſtitution ſeems not to be natural to this climate, where the temper of the people is as diſtant from the torpid ſtrength of the inhabitants of the north, as from the too delicate and ſenſile habit of the ſouthern nations. Their moderate irritability, joined with a ſufficient ſhare of vigour, is connected with that ſtate of the powers of circulation, in which red blood ſeems to be formed faſter than it degenerates. Hence their full and ſanguine habit; ſo that an Engliſhman may generally be diſtinguiſhed, among the ſouthern people, by the *purpureum lumen* which ſhines upon his countenance. Yet we frequently ſee this ſanguine *plethora* exchanged for a bilious one, in conſequence of an alteration which the conſtitution ſuffers from a warm climate. Perhaps a ſimilar change may be induced by the other cauſes which I mentioned; to ſome, or all of which, the people who, in this country, complain moſt of a redundancy of Bile are generally ſubjected.

I ACKNOWLEGE that we are exceedingly ignorant of the manner in which the fluids are changed in digeſtion, circulation, or ſecretion; for we are acquainted with no analogous proceſs that can produce the ſame effects. There muſt always then be ſomething obſcure, and unſatisfactory, in our idea of theſe operations. With reſpect to the redundancy of Bile, we only know, that in the hot climates, where it is moſt remarkable, and, as it were, univerſal, it is connected with a greater irritability in the nervous ſyſtem, a quicker circulation, and a greater tendency in the fluids to putrefaction. And the firſt of theſe affections ſeems to be that which is fundamental; for if it be true that the animal body preſerves conſtantly the ſame temperature, in varying conditions of the atmoſphere, its fluids may be conſidered as expoſed always to the ſame degree of warmth. The external heat, in this caſe, can only affect the body as a ſenſible and irritable machine; and its other effects muſt depend upon the change produced in the nervous ſyſtem. And we find, that when this ſyſtem is affected in a ſimilar manner, that is, excited in an extraordinary degree by other cauſes, the circulation, and the ſeptic animal proceſs are both accelerated. In conſequence of violent paſſion, of exceſſive muſcular motion, of ſtrong convulſions, in ſeveral inſtances quoted by Dr. Haller, a great tendency to putrefaction ſeemed to have been very ſuddenly induced.

On the other hand, in the caſes of a torpor, and low excitement of this ſyſtem, the ſeptic animal proceſs ſeems to proceed more ſlowly than ordinary. It is remarked by Dr. Haller, that all the wonderful accounts of people, who had lived a long time without taking in any aliment, relate to perſons whoſe irritability was conſiderably impaired. They were either melancholy, fooliſh, ſtupid, lethargic, or inſenſible from ſome evident injury of the nerves *.

I SHALL be accuſed, perhaps, of an attachment to a ſyſtem, in endeavouring to find every where a connection between the bilious conſtitution, and an acceleration of the ſeptic animal proceſs. And I confeſs, that having formed an opinion concerning the origin of the Bile, I cannot help being influenced by it. Yet let it be remembered, that in ſupporting this opinion, I only attempt to trace the relation of facts, ſo that my miſtakes will be readily detected by obſervation.

THE excretories of the Bile are as much appendages to the alimentary canal, as to the liver; and being intimately connected with the former organ by their function, are ſo conſtituted by Nature as to ſympathiſe with its different ſtates. A nauſea, by whatever cauſe excited, the

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* Phyſiolog. L. XIX. ſ. ii. 7.

the action of an emetic or purgative, ſeem to be always attended with a temporary increaſe of the biliary diſcharge. But theſe agents are ſo far from producing the conſtitution we were treating of, that they are to be reckoned, at leaſt, among its palliative remedies. Yet, as a redundancy of Bile is generally connected with a diſordered ſtate of the alimentary canal, it may be doubted whether this is not always the primary affection, and the cauſe of the former. The agreement, however, of ſo many facts, tending to ſhew that this ſtate of the Secretion is frequently the effect of a certain diſpoſition of the circulating fluids, renders it equally probable that the redundancy of Bile is often the primary affection; and by the proviſion of Nature excites that nauſea which conduces to its evacuation. A tincture of Bile in ſpirit of wine is ſaid to be a very efficacious emetic *; and it appears probable that the fluid will have

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* Arnauld Hiſt. Natur. des Anim. t. iv. p. 98.

this operation the more readily, where it is ſecreted in a more acrid ſtate, and where the alimentary canal, and the whole conſtitution are exceſſively irritable; both which circumſtances ſeem to occur in the caſes of a redundancy of Bile, from a general diſpoſition in the habit.

THOSE concretions which are found in the paſſages of the Bile, and in its reſervoir the gall-bladder, have lately very much employed the attention of phyſicians. They were not thought of, until the diſſection of human bodies grew into faſhion; and ſince that time they occur ſo frequently, that he who is inclined to attribute to them much influence, has reaſon to ſuſpect them in a variety of diſorders. Yet it appears, that they very often reſt idle and inactive, without producing any of the ſymptoms which are believed to be the moſt characteriſtic of them; and that they are ſometimes conſiſtent with a ſtate of perfect health. And if, in certain caſes, an indiſpoſition of the alimentary canal, after continuing a long time, has at length been accompanied by a jaundice, we muſt not immediately conclude, that the preceding complaint was the effect of a gall-ſtone, which diſcovers itſelf at laſt by a more peculiar and diſtinguiſhing ſymptom. For it muſt be remembered, that the jaundice itſelf is no certain mark of the preſence of a gall-ſtone; ſince it frequently happens independent of it, particularly in the people who are ſubject to diſorders of the firſt paſſages. But ſuppoſing that there is really a gall-ſtone in the caſe, it will ſtill be difficult to determine which was the primary affection. Nor can we affirm, in our preſent ignorance of the cauſe of theſe concretions, that a diſturbance of the ordinary motions in the alimentary canal may not contribute to their formation.

YET I do not pretend that a gall-ſtone will not, in certain conſtitutions, produce effects before it preſents itſelf in the paſſage to the inteſtines, and excites the efforts of Nature for its expulſion. But theſe effects are not ſo preciſely determined, that we are capable of diſtinguiſhing them from the ſymptoms of other affections. And if they were, we ſhould only feel the mortification of being obliged to reſt ſpectators of a diſeaſe, in which art can do nothing of conſequence, at leaſt before Nature points the way. We ſhould ſcarcely attempt, though we knew the means, to puſh into the ducts a ſtone, with whoſe ſize and figure we are unacquainted *. And if we conſent that it ſhall lie undiſturbed in the gall-bladder, can we expect to get rid of it in the gentler way of diſſolution?

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* Cave autem ne me propterea timidiorem voces, in eo videlicet morbi genere, in quo ſupra oſtenſum eſt quieſcentibus calculis nihil ſæpenumero moleſtiæ percipi. Morgagni, l. c. 50.

tion? It remains to be proved, that a urinary calculus was ever diſſolved, in the body, by the remedies which we employ for that purpoſe? Its troubleſome ſymptoms have been made to diſappear; but that has ſometimes happened ſpontaneouſly, or been effected by remedies which poſſeſs little or no diſſolvent power. Yet certainly the bodies which are moſt active in this way, being all of the ſaline kind, have a better chance of paſſing by the kidneys, than by any other gland; they being naturally employed in ſeparating this matter from the blood. But when we attempt to introduce ſuch bodies into the interior parts of the œconomy, we act directly contrary to Nature's plan, and are oppoſed by her in every ſtep. She either does not ſuffer them to go beyond the firſt paſſages; or by ſatisfying their attractions, ſhe robs them of the greater part of their activity. And ſhe ſeems particularly careful not to admit any foreign unaſſimilated body into thoſe animal liquors, which are ſeparated, not merely for evacuation, but to be applied to uſeful and determined purpoſes. Thus, for example, when the Bile is diffuſed through the whole maſs of blood in a jaundice, it paſſes freely by the kidneys, and diſcovers itſelf in the urine; but no trace of it is to be found in the milk. And on this account, it muſt be more difficult to introduce a ſolvent with the biliary than with the urinary ſecretion; Nature being more exact and curious in the preparation of the former fluid.

INDEED, the remedy which has been the moſt ſtrongly recommended for anſwering this intention, need not much alarm her watchful care. It is not ſome powerful agent "*quæ ſubdolè irrepit, et poſitâ intus larvâ ſeſe explicit*" to execute the purpoſe of art. When it is pretended to reſolve theſe concretions by the uſe of graſs, phyſicians ſeem willing to pay a coma compliment to Nature, and by propoſing to do ſo little themſelves, to ſhew how much they expect from her. Yet I dare not deny, that people in jaundice have been relieved by turning them out to graze with the cattle; for the fact is ſupported by one of the moſt illuſtrious names in phyſic. But he muſt be credulous indeed, who can ſuppoſe that this diet, after having ſuſtained the action of the animal powers, and been converted to chyle, to blood, and at laſt to Bile, is indued with the power of diſſolving the biliary concretions. If we were to reaſon from analogy, we ſhould expect the very oppoſite effect from ſuch an aliment. It has been obſerved already how ſimilar the Bile is in its compoſition to the milk; and we know that the milk of the animals, who feed on vegetables, is more diſpoſed to concretion than that of carnivorous creatures; and that when the latter are fed upon vegetables, their milk becomes more concreſcible. The Bile, as well as the milk, is more viſcid in the phytivorous animals, than in the human ſpecies; and this muſt depend upon the condition of that coagulable part, which is common to both theſe liquors. It ſeems likewiſe to be more diſpoſed to a ſpontaneous concretion; for nothing is more common, according to Ruyſch, than to find extenſive concretions in the biliary pores of ſheep and oxen. This appearance ſhews a great diſpoſition to coagulate, which operates even where there is little opportunity for ſtagnation; and in all the diſſections of human bodies by Morgagni and Valſalva, it was only once obſerved, *Vix uno in jecinore mihi accidit olim ut invenirem, Valſalvæ autem in nullo, quod ſciam* *. It is not therefore probable, that a diet of graſs has any tendency to promote the diſſolution of biliary *calculi*, by the change which it produces in the general maſs of fluids, and of conſequence in the ſecretions. It ſeems even to give a more concreſcible Bile, as well as a more concreſcible milk; and this we might have preſumed, from obſerving that the animals, which want a gall-bladder, are of the herbivorous kind; while the carnivorous have all gall-bladders *, and theſe interlaced with large *plicæ* †; to favour, one would think, a ſtagnation, which in the Bile of theſe animals does not ſo readily produce concretion. And if, from the uſe of graſs, a jaundice diſappears ſooner than from the unaſſiſted efforts of Nature, this probably depends upon its effect on the inteſtines. Almoſt every kind of freſh vegetables has a tendency to bring on diarrhœa; a circumſtance ſo favourable to the cure of jaundice, that we chiefly confide in the remedies which are capable of producing it.

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* Ep. Anat. Med. XXXVII. 11.

THE evacuation of *calculi*, or *calculous grumes*, which was obſerved by the Baron Van Swieten to occur very commonly during the uſe of the graſs, muſt be referred, I imagine, to the greater determination of Bile into the inteſtines, and to the increaſe of that action of the excretories of the liver, by which they deliver themſelves from obſtructions. But, as this effect may be obtained by a gentler and leſs diſguſting method, I do not wonder that the uſe of graſs, which ſeems to have no ſpecific quality againſt this diſeaſe, has been generally neglected in England; though the firſt hint to it was given by one of our own countrymen *, and it has ſince been patronized by the moſt eminent phyſicians abroad †.

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* Hall. Elem. Phyſ. L. XXIII. Sect. ii. § 1.

† Ibid. § 3.

SINCE, therefore, art can do ſo little in removing theſe concretions, it ſhould endeavour to trace them to their origin, and diſcover, if poſſible, the means of preventing their formation.

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* Gliſſon.

† Boerhaave, Van Swieten, Morgagni, &c.

WE have found the Bile compoſed chiefly of that fluid, which ſeems to be the ſource of moſt of the hard concretions obſerved in the animal. Thoſe who have attended to the formation of the bones of the *fœtus*, of *calli*, of the ſhells of animals, aſſure us that they have all their origin in a coagulable matter. In a theſis publiſhed lately at Edinburgh, by my ingenious friend Dr. Baddeley, the Reader will find the ſtrongeſt reaſons for believing, that the urinary *calculi* are formed from the ſame ſubſtance. The cheeſy concretions, which are frequently found in the *mammæ* of women, are certainly nothing but the coagulable part of the milk; and theſe do ſometimes acquire a conſiſtence that is perfectly ſtony *. The concretions occurring in the paſſages of the chyle †, which, in ſome deſcriptions, are ſaid to be of a cheeſy ſoftneſs, and, in others, of a conſiderable hardneſs, have without doubt their origin in the ſame matter; for this fluid, we know, is eaſily coagulable. It has lately, it ſeems, been diſcovered in Sweden, that the aſhes of bones are a compoſition of calcareous earth, and the acid of phoſphorus. Mr. Margraaf obſerves, that theſe two bodies being united produce a gelly; which has this peculiar property, that it will not diſſolve in boiling water repeatedly poured upon it, but remains of a tenacious gluey conſiſtence *. And others have remarked, that the ſerum of the blood, being left to putrefy, degenerates into a calcareous ſubſtance. Does it not ſeem probable, when one compares theſe facts, that the coagulable part of the animal fluids is compoſed of a calcareous earth, together, perhaps, with the acid of phoſphorus; and is on this account ſo liable to put on a ſtony form?

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* Hall. Phyſiolog. L. XXVIII. Sect. i. 23.

† Ibid. L. XXIV. Sect. ii. 2.

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* Opuſc. Chym. T. 1. Diſſ. VI. p. 168.

As it appeared, from the Experiments, that there was a conſiderable quantity of an evolved phlogiſton in the Bile, ſo we find that its concretions differ from the others, in being generally coloured, and generally inflammable. Yet there are exceptions, with reſpect to both theſe qualities; for ſome appear perfectly white throughout their ſubſtance, and others as perfectly black; and theſe two kinds are ſaid not to be inflammable *. Their colour is liable to great variety; which we muſt attribute to the various relations of the principle of this quality, and its being eaſily, therefore, ſuſceptible of alteration.

THE biliary *calculi* appear to have been all ſoft in their original ſtate, like the cheeſy concretions of the milk; for they are ſometimes found of this conſiſtence †;

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* Haller, Morgagni. They reſemble the Bile calcined, or deprived of its phlogiſton, by the vitriolic and muriatic, and by the nitrous acid. Exp. VIII.

† Nam vel majuſculi interdum caſei recentis mollitiem ſervant. Morgagni, XXXVII. 19.

and many of the harder ſtones appear to have been formed of a certain number of ſmall concretions, compacted together while they were ſoft and yielding [*]; and often, when the external cruſt is quite ſtony, the internal part retains the colour, and nearly the ſoftneſs of Bile.

THEIR external figure is extremely various; but in general it appears to have been round originally [†], and that the deviations from this form have ariſen from compreſſion, while the concretions were in a ſoft ſtate. With reſpect to the internal arrangement, many of them are compoſed of concentric layers, of a circular or other figure, correſponding with that of the ſtone. In others, there is an appearance of *radii* drawn from the center to the circumference; but this is much rarer, and the ſtones look as if they had undergone a chryſtallization. And there are many, which diſcover no reſemblance with either of the above forms; as the calcareous, and the black concretions, which were taken notice of before; and another kind, that, according to Morgagni, occur very frequently. Theſe contain under the external cruſt a large *meditullium*, which appeared to the profeſſor to be ſoft and natural Bile, and he was puzzled to gueſs how it ſhould get there. And ſometimes, where one ſtone is compoſed of ſeveral others, each has a different center, and ſome difference perhaps in the arrangement of its parts.

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[*] Morgagni, l. c. et adverſar. animadv. III. 28.

[†] Morgagni, l. c.

THAT vice of the conſtitution, with which theſe concretions are neceſſarily connected, ſeems to be buried in the greateſt obſcurity. It has been ſometimes imagined to be the ſame with the diſpoſition to urinary calculus. But this opinion is contradicted by one of the beſt eſtabliſhed facts with reſpect to the conſtitution liable to Biliary concretions. For they never, perhaps, occur in infancy, and very rarely in youth. Morgagni aſſures us, that in the whole number of people in whom gall-ſtones are ſaid to have been obſerved, there are ſixty-one aged, and only eight young folks [*]. Of the laſt the oldeſt is twenty-nine, and the youngeſt twelve; who is the only boy in the liſt. Another fact, which ſeems to be ſupported by pretty good authority, is their connection with an inactive life, and a want of bodily exerciſe. For, according to Boerhaave, the diſeaſe is, on this account, more common among literary men [†]. And Haller aſſures us, that the gall-ſtones occurred very frequently in criminals, who had been long in confinement. To the ſame cauſe might be referred perhaps their greater frequency in women; but this fact, though ſupported by Haller, Coe, and others, is denied by Morgagni, from a compariſon of the whole number of obſervations. If it be true alſo, as Dr. Haller ſeems to ſuſpect [‡], that they are found oftener in particular countries, this will probably be attributed to a particular food, and manner of living. Gaubius appears to be ſatisfied of the influence of the laſt-mentiontioned cauſe, and in accounting for the concretion, he combines it with the preceding. *Alimento cæterum ſicciori, ac vitæ deſidi concretio iſta præcipue debetur* *.

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[*] Ep. XXXVII. 15.

[†] De Vir. Medic. p. 301. [‡] Opuſc. pathologic.

But in theſe circumſtances of the conſtitution, is the Bile ſeparated with a greater diſpoſition to concrete? Or do they only operate by favouring its ſtagnation? I fancy it will be difficult to determine theſe queſtions; for, though it is impoſſible to deny the former, its affirmation will be found, I believe, incapable of proof. Does the *vita deſes*, a life with little muſcular motion, produce a more concreſcible ſtate of the animal fluids? I am aſſured, that blood drawn from the animals which ſleep during the winter, while they are in their torpid ſtate, does not coagulate at all. And yet, all the circumſtances of the *vita deſes* ſeem to be preſent here in exceſs *.

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* Patholog. § 579.

BUT, will the Bile always concrete ſpontaneouſly, when it is allowed to ſtagnate longer than uſual? There is a caſe in Lieutaud, taken from De Haen, of a tumour of the belly, which was found on diſſection to depend, in part, on a vaſt diſtenſion of the gall-bladder. This organ contained in ſeveral loculi eight pounds of Bile, which was indeed very thick, becauſe much of it muſt have ſtagnated a conſiderable time; but it is not ſaid that any of it had concreted †. In the Human Bile, which I kept until it grew putrid, I never ſaw any concretions happen, that ſhewed the ſmalleſt reſemblance to the biliary calculi, in what is ſaid to be their original ſoft ſtate. Some ſpecks of it only, here and there, would ſtick tenaciouſly to the ſides of the glaſs; except when the Bile had previouſly been mixed with water; and then, indeed, there was always a large pale-coloured depoſition, as ſoon as it began to putrefy. When the Bile ſtagnates long in the bladder, and grows more viſcid, it generally, I believe, becomes more deeply-coloured; and the moſt viſcid that I have ever ſeen, was as dark as pitch. But the colour of the ſoft biliary concretions is commonly very different; a yellow, verging to a green; or exactly that of the Bile coagulated by the vegetable acid. Such are the *molles virideſque pilæ*, which are frequently mentioned, as having been evacuated by people in jaundice, and are conſidered by Haller among the primordia of theſe concretions*. Of the ſame ſort appear to be the *molles intus globu-*

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* Mr. Hewſon has lately explained this fact, very ingeniouſly, from the mere effect of cold. Experiment. Enquiry.

† L. 1. Obſ. 858.

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* Phyſiolog. L. XXIII. S. III. 11.

*lique ſebacei**; for we remarked before, that ſome obſervers had miſtaken the coagula of the Bile, formed by the acids, for ſebum, or fat†. Morgagni gives us a very particular deſcription of a ſoft concretion found in the gall-bladder; and the terms agree exactly with the appearance of Bile coagulated by the vegetable acid; *habuit in Cyſti—Maſſam ex fulvo obſcuro cæruleam, et viridiſcentem, eamque mollem* †. And in fact, we obſerve, that the animal which is more than any other ſubject to theſe concretions, has no gall-bladder; that they do not therefore depend upon ſtagnation, in this creature, but rather, as they are found in the ſtomach, upon a coagulation of the Bile, by the acid generally preſent in that organ, is extremely probable. I mean, at preſent, the animal that furniſhes the bezoar; which, from the taſte and colour it gives to water ‡, appears to be a real gall-ſtone.

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* Page 32. † Ep. XXXVII. 45.

‡ Phyſiolog. Hall. L. XXIII. S. iii. 11.

But from what other ſuppoſition, can we explain the particular appearance of thoſe calculi, which ſeemed to Morgagni to have been formed around a nucleus of ſoft Bile? Can we imagine that the natural Bile had inſinuated itſelf through the firm, denſe, external cruſt; or that the calculus was originally a hollow globe, its cavity prepared for the reception of this nucleus? Is it not much more probable, that the whole concretion was in the beginning a coagulum of the Bile formed by an acid; which neither in conſiſtence, nor colour, differs much from ordinary Bile; and that while its external part was gradually altered by preſſure, &c. its center defended from the action of theſe cauſes, retained the original colour, and ſoftneſs? Morgagni tells us, that the ſize of this ſoft *meditullium*, was always larger in proportion to the ſize of the ſtone.

THE only concretion of this kind, which I have had an opportunity of examining, upon being broken, and put into ſpirit of wine, gave to it not a yellow, but a green colour; and this, the reader will remember, was a diſtinction between the natural, and the coagulated Bile. (Exp. XXI.)

WE have conſidered the moſt ordinary appearance of gall-ſtones in their original ſoft ſtate; which ſeems to correſpond with the moſt ordinary appearance of the coagula of the Bile, formed by the vegetable acid. But there is a variety, which I am convinced by experience will ſometimes, though leſs frequently, happen. I have mentioned ſome Cyſtic Bile, that, when coagulated by the vegetable acid, was not of a greeniſh-yellow, but of a dark colour *. This coagulum, after being kept ſome time, is now perfectly black throughout, and extremely brittle.

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* Note, pag. 11.

brittle. The Bile will ſometimes probably, in the living animal, be in a ſimilar ſtate; and then, if it ſhould happen to be coagulated, the colour of the concretion, as well as of the future ſtone, will correſpond with the appearances which we have juſt deſcribed. And this obſervation may ſerve to explain the *concretiones pillulares nigricantes*; which are likewiſe taken notice of by Haller, while he is relating the deſcriptions of theſe calculi, in what ſeems to be their primitive ſtate.

IT is extremely probable, therefore, that many of the concretions are originally Bile coagulated by an acid; which being no longer miſcible with the liquor of this ſecretion, if they are not evacuated immediately, but allowed to ſtagnate, may acquire a ſtony hardneſs, like the cheeſy concretions in the mammæ. But where is there any opportunity for the action of an acid upon the Bile, before it gets into the inteſtines, and quite clear of thoſe paſſages, in which alone the biliary concretions ſeem to conſtitute a diſeaſe? This is difficult to determine; but I think the following appears to be the moſt obvious way of conceiving the operation. We believe that there is an influx of a liquor with ſome acidity from the ſtomach into the *duodenum*; and that naturally all the Bile, or the greateſt part of it, is coagulated almoſt as ſoon as it gets into the inteſtine*. But may not a little of this acid inſinuate itſelf ſometimes into the end of the *ductus communis*; where if it but touch the Bile, ſo much of this liquor as has felt its influence, muſt immediately take the form of a cheeſy concretion?

AND there are ſome obſervations that make this notion appear probable. For frequently ſuch ſoft concretions are found in the end of the *ductus communis*; of which there is an inſtance in the caſe from Morgagni that we mentioned before*. Here, indeed, there was ſome of the ſame kind of ſoft concretion in the bladder, the cyſtic, and common ducts; and as that, in the laſt, appeared to be the hardeſt, Morgagni concludes with reaſon, that it had grown gradually firmer in its paſſage from the bladder towards the inteſtine. But, might it not have previouſly paſſed from the *ductus communis* into the bladder? And when Haller relates the hiſtory of a light-coloured coagulum in this duct, with ſome harder rounded pieces, *cum durioribus globulis*, in the gall-bladder, is it not evident, that, in this caſe at leaſt, the concretion had begun in the *ductus communis*, and that its parts had been moulded, and gradually acquired conſiſtence, in their paſſage through the duct into the bladder *?

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* Pag. 131.

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* Pag. 172.

But how ſhall we explain that globular form which is perceived to have been original in all theſe ſtones †, except by ſuppoſing that they acquired it when ſoft and newly coagulated, from the preſſure of the ſurrounding duct? We find, that in general the concretions are exceedingly ſmall, and correſpond very nearly with the ſize of the extremity of the *ductus communis*; and that many of the large ſtones are compoſed of theſe elements, as it were, united together. But there are ſome obſervations, with reſpect to this kind of calculi, which ſeem to prove that each of the component concretions had been formed in the ſame mould. Such is the account of a calculous globe, that ſeparated into ſixty leſſer calculi, each of which weighed a ſcruple *. This entire correſpondence in ſize makes it extremely probable, that every one of the concretions had, in its origin, been confined by the ſame bounds; or, in other words, that they had been all formed in the extremity of the *ductus communis*.

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* Hall. Phyſ. L. XXIII. Sect. iii. § xi.

† Morgagni, Ep. cit. 19.

The fluid here, and in the cyſtic duct, is evidently ſuſceptible of motion in oppoſite directions; and is naturally conveyed from the *ductus communis* into the gall-bladder, and from this reſervoir back into the duct, and ſo into the inteſtines. There is probably intereſted in this motion a contractility of the ducts, ſimilar to that which is obſerved in the alimentary canal; ſo that, according to the determination, the ſame muſcular fibres propel the contents of the tube, either the one way or the other. Now, ſuppoſing ſuch a coagulation, as we mentioned, to have happened in the extremity of the duct; while it is yet ſoft, and almoſt fluid, it will obey very readily any impulſe, and may either be puſhed into the *duodenum*, or carried into the gall-bladder, according to the determination of the motions in the ducts. If it paſſes into the *duodenum*, it will purſue with their contents the courſe of the inteſtines; and though it ſhould be carried into the gall-bladder, it may ſtill never become a *calculus*, if this organ evacuates its contents quickly and perfectly; for then it will paſs through the ducts, in a ſoft ſtate, without much difficulty, and perhaps without producing jaundice *. Indeed, if it were to continue in the paſſage where it is formed, the conſequence muſt be a perpetual jaundice; and therefore the neceſſity of getting rid of it will prove a ſtimulus, we may ſuppoſe, to the irritability of the parts, and excite their action. And if, from a ſpaſm of the fibres of the *duodenum*, or from a diſtenſion of that gut, or from ſome other cauſe which we are not perhaps acquainted with, the paſſage into the inteſtine ſhould be difficult, the concretion, together with the Bile in the *ductus communis*, and *cyſticus*, may be puſhed into the bladder. This will anſwer the preſent purpoſe of the œconomy, which is only the removal of an obſtacle to the paſſage of the Bile, as well as if the coagulum had been thrown into the inteſtines.

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* Morg. l. c. † Morg. l. c.

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* Morgagni, l. c.

In young perſons, we may believe, the irritability of theſe parts is more conſiderable; there is a more conſtant determination of Bile into their inteſtines, as appears from the natural frequency and colour of their ſtools; and little ſtagnation is allowed in the gall-bladder. In children, therefore, though the ſame coagulations happen, and moſt probably occaſion thoſe tranſient jaundices to which they are

liable,

liable; yet the natural contractility of the parts, excited eſpecially by the ſtimulus of a purge, ſoon frees the conſtitution from them, while they are in a ſoft ſtate. And in children, hard biliary *calculi*, are, perhaps, never found, though they are ſometimes paſſed in the form of ſoft concretions *.

But in old age, naturally, and ſooner, from certain cauſes, as particularly a ſedentary life, the inteſtines, and their appendages become more torpid; the determination of Bile into their cavity is diminiſhed, and its ſtagnation in the gall-bladder permitted. When coagulations happen in theſe circumſtances, they have a greater chance of getting into the gall-bladder, as well as of continuing there until they acquire a ſolid conſiſtence.

We are not, after this view, ſurpriſed at the difficulty which Morgagni finds in diſtinguiſhing between biliary and inteſtinal concretions; nor will it ſeem extraordinary, that ſome, which had all the appearance of the former, ſhould be only attended with the ſymptoms that belong to the latter *. For, ſince the Bile appears to be naturally and conſtantly coagulated in the inteſtines †, it may form there, whenever it ſhall be obliged to ſtagnate for a conſiderable time, concretions which muſt very much reſemble thoſe found in the gall-bladder, as they have the ſame origin.

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* Calculi ex puero annuo piſi mole molliculi multi. Hall. l. c. ex Adol.

One would imagine that Gaubius had entertained ſome ſuch notion as this of the formation of biliary *calculi*; for he obſerves, that the *primæ viæ*, and the paſſages which have the neareſt communication with them, as the organs deſtined to the Bile, are particularly liable to ſtony concretions. And he adds, *Dixeris ideo humores, qui crudorum permixtioni præ reliquis patent, præcipuè lithiaſin contrahere* *; a remark which ſeems to be inexplicable, except upon the ſuppoſition which we have ventured to offer. For, however near the liver and its appendages may be to the alimentary canal, we certainly do not imagine that there is any matter in the biliary ſecretion, which has not gone through the courſe of the circulation, and been ſeparated in the proper organ. Yet, as the obſervation of Gaubius is not confined to the excretories of the Bile, but includes, at the ſame time, the urinary organs; we muſt confeſs, we do not ſee how theſe have any particular communication with the *primæ viæ*, or can be liable, on that account, to an admixture of crude and unconcocted matter in the fluid they ſeparate from the blood.

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* Morgag. Ep. c. 45.

† Pag. 131.

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[*] Patholog. § 567.

One of the ſimpleſt forms of theſe concretions become calculi appears to be that, in which the external part only has been gradually changed, and by this ſort of degeneration has acquired a white, hard, ſtony figure; while the internal part retains its original colour and conſiſtence. If we ſuppoſe this degeneracy to have proceeded farther, and to have altered, by degrees, the whole texture of the concretion, we ſhall get an idea of that kind of calculi, which appeared to be calcareous throughout their ſubſtance. But the firſt ſort of concretion, while it lies in the gall-bladder, or in any other place that is ſubject to the continual, or frequent afflux of Bile, may attract, from that fluid, its ſimilar parts; and, in conſequence of ſubſequent depoſitions, thoſe concentric layers, which are commonly obſervable in the larger calculi, will be gradually formed.

Another ſimple form of theſe concretions, is that which was obſerved to happen to Bile in a particular ſtate, that differs, we know not how, from the ordinary one, in conſequence of the action of the vegetable acid. Theſe are dark-coloured at firſt, and gradually become quite black, hard, and brittle, throughout their ſubſtance*. And if we join to theſe reflections, that the form of the coagula, while they are in a ſoft ſtate, may be changed by preſſure, and that ſeveral of them may be compacted together, we ſhall have a notion of the origin of the greater part of thoſe varieties of biliary calculi, which are upon record. There is one ſort, however, which ſeems to have undergone an actual chryſtallization; nor will this ſeem very extraordinary, if we ſuppoſe that the coagulable lymph, which makes the chief part of theſe concretions, is a compoſition of calcareous earth, and the acid of phoſphorus. For may not it, like other combinations of this earth with acids, be diſpoſed, in favourable circumſtances, to ſuffer a chryſtallization?

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* Vid. Pag. 175.

Yet we do not pretend to include in this idea every ſpecies of biliary concretion. There are ſome, as for inſtance thoſe which are found in the biliary pores of oxen, that are evidently ſpontaneous. And their different appearance ſhews very plainly, that they differ in their origin from the ſtones of which we were treating. The continuity of the concretion, through the extent of ſeveral veſſels, does not look like the very partial application of a coagulant, as in the former caſe, but like a general diſpoſition in the fluid to concrete. *Sæpe mihi viſi hujuſmodi tubuli tantæ longitudinis, ut ſi modo integri eximi potuiſſent, plurimas pori bilarii ramificationes continuatâ lapideâ ſerie coralli inſtar retulerint* *. Concretions of an analogous form, have ſometimes, though very rarely[†], been obſerved in the human liver; and we ſhould naturally ſuppoſe, that they might happen more readily in the gall-bladder, where there ſeems to be a better opportunity for ſtagnation. I remember to have ſeen a biliary concretion, which appeared to be of this ſort. It was an irregular maſs, of a brown colour, that readily crumbled between the fingers; and a piece thrown into ſpirit of wine, gave it very quickly a yellow tinge.

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* Gliſſon de Hep. p. 105.

I SHALL mention the few experiments which I have had an opportunity of making on theſe concretions, though they may be reckoned, perhaps, ſcarcely worth recording. There is a variety, in the account of their properties, that might lead one to imagine a conſiderable difference in their compoſition. But ſome of theſe properties; for inſtance their ſpe-

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[*] See pag. 160.

cific gravity, according to the common way of determining it, ſeems to be eaſily alterable. A concretion being broken into two pieces, each of them was obſerved to ſwim in water. One was taken out, and thrown into vinegar; where it ſwam for ſome time on the ſurface of the liquor, but afterwards ſubſided to the bottom. Being now taken out of the vinegar, and put into water, it ſunk immediately. The other piece continued a much longer time on the ſurface of the water, where it left an oily ſcum; but, at laſt, it fell to the bottom. Yet both theſe pieces, when they had remained ſome time in a dry place, were found to have recovered their property of ſwimming in water. Another round calculus, with a hard poliſhed ſurface, continued in vinegar twenty-four hours, and was expoſed to heat, without ſubſiding to the bottom.

Oil of vitriol, poured upon one of the ſtones, produced heat, changed its colour to black, and ſoftened it into a gelatinous or gluey conſiſtence; ſo that it ſpread itſelf around the bottom of the glaſs, adhering tenaciouſly to the ſurface.

A PIECE of one of the concretions, with concentric layers, being put into aquafortis, and the veſſel ſet before the fire, a flame-coloured vapour aroſe from the liquor, and the acid acquired a yellow colour. When the ſtone was taken out, and thrown into water, it aſcended to the top, and ſhowed a white, brittle, corroded ſurface.

PIECES of the ſame kind of concretion were put into *ſpiritus nitri dulcis*; which extracted from them a brown tincture. They were entirely ſtripped of their colour, and got the appearance of pieces of chalk. Strong ſpirit of vitriol poured on theſe pieces, produced heat, changed their colour to red, and then to black;

and ſoftened them into that gelatinous conſiſtence already deſcribed.

Some ſmall black granular concretions, being put into ſpirit of wine, did not ſeem to be affected by it, in the cold. But others, of the ſame kind, being put into a mixture of ſpirit of wine and *aqua fortis*, a green tinge was obſerved ariſing from the ſtones, and ſpreading itſelf in the liquor; which, at length, acquired a ruſt-colour; but theſe concretions were not rendered white.

Some pieces of the concretions, with concentric layers, were put into ſpirit of wine, and ſeemed to be little affected by it, in the cold; for they only communicated to it a ſlight yellowiſh tinge. But when heat was applied, for ſome time, the ſpirit diſſolved them; got a viſcid appearance; and an infinite quantity of little ſhining lamina, like bits of talc, were diſcovered ſwimming about in the ſolution.

Some oil of turpentine being poured upon a concretion, and the veſſel ſet in a warm place, the oil acquired a brown colour, and the ſtone was ſo ſoftened, that it broke into ſmall pieces with the little agitation that was uſed. Yet it did not appear to be diſſolved, or to have mixed uniformly with the oil.

Two firm biliary calculi had been expoſed to heat, in ſpirit of wine, for twenty-four hours; yet retained their ſize and form. Some oil of turpentine was added to the ſpirit, in each of theſe veſſels; and a few hours after, in ſhaking and examining the mixtures, I found that the ſtones were fallen to pieces, and the liquor become brown and turbid.

It ſeemed from this experiment, that Valiſnerius had reaſon for aſcribing to heated ſpirits of wine and turpentine, a ſuperiority over the other diſſolvents of theſe concretions*; if by a diſſolution he

* Opere, t. 3. p. 6. Lett. 37.

meant ſuch a change as has been deſcribed. And as the eſſential oils, particularly that of turpentine, ſeem not to be ſo much altered by the digeſting powers, but that they retain ſome diſtinguiſhing properties in the circulation, it will be imagined, perbaps, that their efficacy may be conveyed into the Biliary Secretion.

The alkaline ſalts, both volatile, and fixed, acquired a brown colour from ſome of theſe ſtones; and rendered them much ſofter. But it is pretended that ſimple warm water will produce, in many of them, the very ſame change. An alkali, altered by ſuffering it to lie on Pruſſian blue, extracted from them the deepeſt tinge. This alkali effervesced with all the mineral acids, and produced with them, inſtantaneouſly, a green colour. But with the weakeſt ſolution of iron, and of ſome other metals, it gave immediately a blue colour. Yet, when it had

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acquired a tinge from a gall-ſtone, it produced a green, inſtead of a blue, with the ſolution of iron. And I found, that it was altered in the ſame manner by diſſolving in it a bit of the craſſamentum of human blood. And when the clear red infuſion of the blood in boiling water, was poured into a ſolution of iron, rendered blue by the above-mentioned alkali, it produced immediately a green colour. The addition of ſome human urine to this ſolution, was attended with the ſame change. Theſe Experiments ſeemed to confirm the opinion of a relation between the colouring matters of the Bile, and of the blood. But I ſoon found that a reſemblance in this property was extended through a variety of bodies. For an infuſion of aloes, of tea, of powder of the gall-nut, produced the ſame effect. So did the addition of brandy; though pure ſpirit of wine did not ſeem to alter the blue colour. An infuſion of ſaffron, likewiſe, gave immediately a fine green, on being mixed with the ſolution of iron and Pruſſian alkali. Theſe bodies ſeem to agree in no property, but that of communicating to water a colouring matter. Whether, in all of them, it is of the ſame nature, I will not pretend to ſay; though it has been aſſerted *, that the bluſh of the grape, and the florid colour of our vital current, depend on a common principle. Yet, when I poured ſome port-wine into the forementioned blue ſolution, it did not produce a green, but a purple colour; which might depend however upon ſome foreign matter, as our common wines are ſeldom free from ſuch a mixture.

THE concretions appear to be compoſed of the ſame materials with the Bile; except that they have undergone ſome ſpontaneous change, during their ſtagnation in the body. The colouring matter does not produce that fine vivid green with the acids, which the Bile itſelf, and

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* Traité de la Nutrition, par Monſ. Durade.

the freſh coagulum of this fluid exhibited in the former Experiments. And the coagulable part has acquired the appearance of a calcareous, or chalky matter. When ſome chymiſt ſhall bring us acquainted with the compoſition of the coagulable lymph, and with the particular nature of the colouring ingredient of the Bile, we ſhall probably be able to account for theſe changes.

THOUGH we ſeem to have found a ſource of biliary concretions in the acid of the alimentary canal, it will not, I hope, occur to any one's fancy, that their prevention muſt depend on deſtroying this acid, by means of abſorbents. For if it appears probable, from a view of the only facts relative to this matter, that there is a continual generation of acid from digeſtion, it is equally probable, that this acid has ſome important uſes in the œconomy. Nor are we to ſuppoſe, that it ever gives occaſion to concretions in the biliary duct, during a perfectly ſound and natural ſtate of the animal. Their production is moſt probably the conſequence of ſome diſturbance, or inverſion, of the ordinary motions in the alimentary canal, and in the ducts its appendages. It is obſerved by an eminent phyſician, that ſeveral of his patients, after being troubled, for years, with complaints which they referred to the ſtomach, have at length been ſeized with a jaundice *. He ſuſpected, therefore, that the preceding ſymptoms aroſe from biliary concretions, which had not yet entered the *ductus communis*; or, perhaps, had been evacuated before they acquired bulk enough to obſtruct the paſſage of the Bile. What would be the ſymptoms in the latter caſe, it muſt be difficult to ſay; but we have numerous obſervations of ſtones continuing a long time in the bladder, without producing any kind of ſymptom.

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* Medic. Eſſ. of the College of Phyſicians.

It ſeems exceedingly probable, that the diſorder of the alimentary canal was primary; and that ſuch a ſtate of it is more favourable to the formation of theſe concretions. I am inclined to believe alſo, that this is a reaſon why biliary calculi are frequently connected with the gouty, and nephritic conſtitution; theſe diſtempers being ſo apt to affect particularly the alimentary canal, and diſturb the natural order of its motions.

To eſcape the diſeaſe, we muſt endeavour to avoid thoſe circumſtances of the conſtitution, which appeared to favour its production *. Old-age, alas! we cannot avoid; nor its effect upon the irritability of our organs. It is almoſt as difficult for ſome of us, in the preſent artificial diſtribution of the employments and duties of mankind, to ſhun the miſchief of a ſedentary life. But the management of his diet is certainly in every

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* Vide, p. 168.

perſon's power, whatever path of life he may happen to tread. And if proper care was taken in this reſpect, the influence of the other cauſes might poſſibly be prevented.

We have already attended to that ſympathy, which prevails ſo remarkably between the excretories of the Bile, and the alimentary canal*. It is probable, that the ſtate of motion in the latter organ cannot be altered, without affecting the former. When the periſtaltic action of the inteſtines is greatly accelerated by the ſtimulus of a purge, we obſerve that a vaſt quantity of Bile is very ſuddenly poured into their cavity. In the oppoſite ſtate of the canal, when this action is too dull, and torpid, the motion in the excretory organ of the liver will probably be juſt as languid. The operation of old-age, of a ſedentary life, of the *alimentum ſiccius*, in rendering the conſtitution more liable to biliary concretions, conſiſts entirely, perhaps, in their producing the above-mentioned ſtate of theſe connected functions.

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* Page 152.

THIS is certainly no new diſeaſe, though it was unknown to the ancient phyſicians; yet I believe it to be more frequent at preſent, than it was in their time. For there are many more people now, who loſe their vigour, either in an indolence that is diſturbed only by the avocations of enfeebling pleaſures; or in employments that vex or fatigue the mind, while they deprive the body of its natural exerciſe. And both theſe claſſes of men are very generally ſubject to a weakneſs, and diſorder of the motions in the alimentary canal.

NOR does the ordinary way of living ſeem calculated to obviate, but rather to increaſe the influence of the cauſes we have mentioned. The common uſe of tea, has a tendency to injure the tone of the inteſtines; as well by the warmth of the infuſion, as by its particular ſedative quality. The debility which follows, in a temperament whoſe muſcular power is naturally weak, or has grown ſo from want of exerciſe, muſt be remedied, when it becomes exceſſive, by ſomething cordial and ſtrengthening from the apothecary; or by an application of the ſame kind, prepared without his aſſiſtance. And both theſe practices, when long-continued, are equally pernicious, though they may not be equally ſhameful. But, perhaps, the debility is not ſufficient to drive us to ſuch reſources; and only diſcovers itſelf in a longing, at the next meal, for ſomething that ſhall raiſe our vigour, and ſpirits. This becomes a foundation for the uſe of ſpirituous liquors; which grow from cuſtom to be a neceſſary miſchief, entailed upon the conſtitution. For no one doubts, that the temporary vigour, communicated by this kind of irritations, is ſucceeded neceſſarily by a weakneſs, which calls for a repetition of the former ſtimulus. And when they are long continued, the ſenſibility of the fibres is uſed as it were, and worn out; and they become torpid before the ordinary period of old-age. Our moſt common liquors have an aſtrictive quality united with their ſtimulus. Our beer and wine, by their bitterneſs and roughneſs, augment more conſiderably the tone of the fibres; but it is probable, that in the ſame proportion they tend, by continued uſe, to exhauſt the contractile power. From theſe qualities too, they are apt to occaſion, eſpecially when well-reliſhed with cheeſe, a ſlower motion through the inteſtinal tube; a circumſtance particularly favourable to the production of biliary concretions.

The gout, with its doubtful face which regards at the ſame time the inflammatory, and the nervous diſeaſes, frequently interrupts this courſe by an unwelcome viſit. Yet it ſeems to be a neceſſary, though painful operation; employed by Nature for ſupporting, in the beſt way that we have left her, the vigour of the ſyſtem. One diſcovers in it the ancient ſtrength of the northern conſtitution, ſtruggling with the enfeebling modes of modern life. And, in a little time, it will be loſt entirely in that train of more purely nervous diſorders, which have lately become ſo numerous. Theſe obtain different names according to the theoretical notions of the phyſician, and his patient. They are ſometimes called diſorders of the ſtomach, ſometimes nervous, and at other times bilious diſorders; and generally they have a right to every one of theſe appellations. For it is impoſſible that the nervous ſyſtem ſhould be much injured, and the functions of the alimentary canal remain entire, and unaltered; and ſuch is the ſympathy between this canal and the biliary organs, that they will commonly ſhare in the affection. But it is certain, that they flow originally from a diſorder in that power, which is the ſource of all the motions in the machine.

THE ſafeſt means of maintaining the vigour of the nervous power, and thoſe which Nature ſeems to have appointed, are the application of cold in a certain degree, and proper bodily exerciſe. All thoſe ſources of irritation, which, under the name of ſpirits, bitters, aſtringents, by the ſhort-lived force they occaſion, have obtained the name of ſtrengtheners, may anſwer, indeed, a temporary purpoſe; but their habitual uſe will certainly prove pernicious. Unhappily they are recurred to, for preſent relief, by thoſe who have moſt reaſon to dread their debilitating effect. Such are the people who are confined to the cloſe, and heated air of a chamber, in the purſuits of ſtudy, or buſineſs; a numerous, as well as reſpectable body in every poliſhed ſociety. They ſhould be perſuaded, that a calm and regular tenor of the motions in the ſyſtem, is beſt adapted to their way of life; for, being deprived of the natural means of ſupporting the vigour of the moving power, they muſt manage it with greater caution. In them it is more eaſily excited beyond its proper pitch; and they ſuffer more from its conſequent depreſſions. They would certainly do right, in exchanging all the varieties of ſpirituous liquors for ſimple cold water. It would then be eaſy for them, to mix in their aliment a proper quantity of freſh vegetables, and particularly of the ripe fruits; which commonly diſagree with ſuch people at preſent, becauſe they are joined with fermenting liquors; and their ſtomachs have been ſo accuſtomed to the perpetual uſe of heating ſubſtances, that they can bear nothing of an oppoſite quality. But this part of diet, Nature ſeems to have intended for accelerating, by its mild irritation, the periſtaltic motion of the inteſtines, and ſoliciting the determination of Bile into their cavity; effects which it very conſtantly produces.

In ſuch a ſtate of the motions in the alimentary canal, and the biliary ducts, concretions probably will not be formed; or will be very quickly evacuated. The ſenſibility of the fibres will be preſerved, until worn out by the neceſſary action of the œconomy, it yields to the influence of old age*. The whole nervous ſyſtem, which ſympathizes ſo much with the ſtate of the alimentary canal, that we do not commonly think of affecting it, except by the changes produced in this organ, will acquire an equal, and a durable tone, leſs ſubject to thoſe depreſſions which give occaſion to the attack of a variety of diſeaſes. The gout will probably be avoided; or if its rudiments were interwoven in the ſtamina of the conſtitution, its approach will be retarded; and when it does come, it will be as a friendly viſitor, to increaſe our vigour and ſpirits, and not to attack the very ſeats of life. Our children will bleſs their parents temperance; and certainly it were better to inſure them a good conſtitution, than to loſe our ſtrength in the anxious purſuit of wealth, that we may furniſh their feeble bodies with the occaſions of growing ſtill more wretched. Perhaps, by ſuch a management, we might at length exterminate this variety of nervous affections; which are not the native growth of a climate, whoſe temperature ſhould produce in its men, as well as its horſes, a ſtate of the muſcular power that gives equal vigour and agility; but are the hot-bed productions of luxury and indolence. And, certainly, they are more troubleſome both to the phyſician and the patient, even than thoſe contagions which induſtrious and adventurous Europeans have imported from the torrid zone. Both together they are the curſe of modern times; and mark a period in the hiſtory of Europe, diſtinguiſhed by its commerce, its riches, and its wretchedneſs.

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* The learned Dr. Haller at tributes to his uſe of water alone, ſince his early youth, the preſent perfection of all his ſenſes, and particularly of his eyes; although he has exerciſed them ſo much in microſcopic obſervations.

YET I feel, while I am writing, that theſe remarks will have little practical uſe. I ſhall not gain a ſingle convert, even amongſt thoſe people whoſe refined feelings, and cultivated underſtandings, muſt make the perfect exerciſe of their faculties, more delicious than any ſenſual gratification. Yet the ſenſualiſt himſelf, if he is wiſe, will be temperate; and preſerve that exquiſite reliſh, which a perfect ſtate of the functions communicates to every animal enjoyment. He remembers how poignant was every ſenſation, while his organs were yet freſh, and unworn;

worn; and will be careful not to waſte, like a prodigal, that ſtock of ſenſibility which might furniſh a life of pleaſure. Nor can he pretend, without riſking an imputation upon his taſte, that any compoſition of the moſt knowing artiſt is half ſo agreeable to the palate, as the fruits which Nature herſelf prepares.

But to ſuppoſe that a temperate way of life will ever become general, in this country, might juſtly paſs for an extravagant fancy. It has been frequently remarked, as characteriſtic of Engliſhmen, that they are prone to exceſſes of every kind. Virtue, vice, frugality, profuſion, and every peculiarity of character, are ſaid to grow to a more extraordinary height in this, than in any other clime. But their free ſpirit rejects the appearance of conſtraint, even in the moſt ordinary matters. In this favourable climate, and in conſtitutions which retain their native vigour, ſuch exceſſes are followed by a puniſhment ſo tardy, that it is frequently confounded among the natural effects of old age.

Our colonies, in the hot climates, retain the full and free manner of living of their more robuſt anceſtors. They imitate, in this reſpect, the leſs poliſhed but more hoſpitable ſtate of their parent country; before a neceſſary oeconomy, an attention to more elegant pleaſures, and the care of a debilitated body, had introduced a greater moderation. They are yet new in their ſettlements, and do not ſeem to have diſcovered the modes of living which are beſt adapted to their ſituation. In general theſe are regulated by faſhion; and are not therefore, always, ſtrictly rational.

——*Falſò plurima vulgus amat.*

YET, I believe, in every country, which has been long inhabited, they will be found to bear a certain relation to the nature of the climate. Its temperature affects moſt remarkably the nervous ſyſtem; and alters therefore the ſtate of our appetites, which is always relative to the conditions of this ſyſtem. And practices, which are ſuggeſted at firſt by inſtinct, are continued from an experience of their utility. The poſterity of the Goths who ſettled in Italy obſerve, through habit and inclination, a temperance which the northern deſcendants of the ſame people feel the greateſt pleaſure in tranſgreſſing.

AND univerſally, in the civilized countries which are ſubject to great heat, the inhabitants are more ſober and temperate. The bounds of moderation grow more contracted, as exceſs becomes eaſier and more pernicious. Yet an apology has been offered for the liberal uſe of wine in the Indies, on account of its ſtrong antiſeptic power. But it ſhould be remembered, that the animal machine will form its own fluids; and that, generally, we are not capable of altering theſe immediately; but only through the intervention of the powers which form and ſeparate them, while we change the ſtate of the motions in the oeconomy. The firſt and principal effect of moſt of our antiſeptics, is certainly exerted on the living ſolid; and perhaps, when one is to be expoſed, for a ſhort time, to the influence of putrid *miaſmata*, the ſupporting in the body an artificial temporary vigour, by repeated applications to the bottle, may prevent their operation. But it is undoubtedly true, that a continuance of this practice muſt co-operate with the heat, in bringing on a premature decay of vigour in the ſyſtem. The ſame objection lies againſt a full and ſtimulating diet; for all great irritations muſt be pernicious, in an oeconomy which is wearing out too rapidly, and where the action is already exceſſive from the ſtimulus of external heat.

THE change induced on the nervous ſyſtem, productive of weakneſs and irritability, ſeems to be the fundamental fault of the conſtitution in theſe climates: from which, as a common ſource, are probably derived the quicker circulation; the more rapid progreſs of the fluids in their ſeptic degeneracy; the redundancy of Bile; the diſpoſition to violent ſpaſmodic diſorders, and to fever. The moſt natural and obvious means of preventing theſe effects of the heat, is the application of cold to the ſurfaces of the body. Bathing, that act of equal voluptuouſneſs and religion in the eaſtern countries; and all the methods of cooling the air by evaporation, which enter into their ſyſtem of luxury; the inhabitants were led to by Nature, and continue, from an experience of their ſalutary pleaſure. To be in poſſeſſion of ice and ſnow during hot weather, requires a little more management and contrivance. But, in ſome of the ſouthern parts of Europe, the uſe of theſe refreſhments extends through almoſt every rank of people. And we are aſſured by their phyſicians, that it is not only a very healthful luxury, but even a remedy of conſiderable importance in the diſorders of their hot ſeaſon. It is ſurpriſing, that the inhabitants of our American colonies do not endeavour to procure this enjoyment in their warm ſummers. They would find an ice in the afternoon, an admirable ſubſtitute for thoſe warm liquors, with which they relax ſtill more their enfeebled ſtomachs; and its expence would certainly be overpaid by its pleaſure and utility.

THE acids approach the neareſt to actual cold in their effects on the oeconomy. They produce a ſenſe of coolneſs, relieve thirſt, oppoſe putreſcency, repreſs the inordinate diſpoſition to motion in the ſyſtem, and give a degree of aſtriction, with a gentle irritation to the parts more immediately ſubjected to their action, the alimentary canal and its appendages. They have been obſerved to relieve that languor and faintneſs, which are occaſioned by exceſſive heat, when no benefit reſulted from the common ſtimulating cordials *. Their peculiar operation upon the Bile, which ſeems to bear the ſtrongeſt marks of Nature's providential care of the oeconomy, has been already conſidered †. And from that view alone we were convinced of the neceſſity of uſing them in greater quantity, whenever the body is expoſed to the continued influence of great heat. They are then demanded by the appetite, and cordially received by the ſtomach; for in hot weather, and in a fever, we bear very well a quantity of

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* Lond. Med. Obſ. vol. i. p. 66.

† Page 134, &c.

acid, that would be apt, in other circumſtances, to diſorder the firſt paſſages.

THESE precautions againſt the heat appear to oppoſe its effects directly; while the ſpirituous liquors, and thoſe warm ſpices of which the Weſt Indians are ſo fond, although they remove for a time the languor of the climate, are hurtful by adding to that irritation which the heat has carried to exceſs. It is an unnatural purpoſe they anſwer, when, by rouſing a feeble ſtomach, they enable a man to eat as much in Jamaica, as he would in England. If we were careful to preſerve the ſtrength of the ſyſtem, by a way of life adapted to the climate, we ſhould feel no occaſion for their temporary uſe. And they ought certainly to be reckoned amongſt the *præſidia valetudinis*, whoſe purpoſe is always temporary; ſince it muſt never be ſuppoſed, that a man is to be ill his whole life. They can be of no advantage, while our ſyſtem retains its natural vigour; and become neceſſary by habit, becauſe they deſtroy that vigour. For the ſame reaſon, they render the ſtomach leſs capable of bearing the action of cold, and the acids; and may deprive us of thoſe remedies which, by lowering the too great excitement that ariſes from the heat, are its proper and natural antagoniſts.

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P. 127. in the Note, l. 4. for *ſoſtrattia i*, r. *ſoſtratti ai*,

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